Imperial Solar Energy Center South

Appendix H1

Preliminary CEQA Level Drainage Study

Prepared by Tory R. Walker Engineering, Inc.

October 4, 2010

PRELIMINARY CEQA LEVEL

DRAINAGE STUDY

for

Imperial Valley South Solar Farm

Imperial County, California

Prepared for:

LightSource Renewables
Development Design Engineering, Inc

June 25, 2010
Revised October 4, 2010

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W.O. 166-03

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1. Description and Project Setting

The proposed 838-acre Imperial Valley South Solar Farm is located on the west and east sides of the Westside Main Canal between Highway 98 and the United States-Mexico border in Imperial County, California. This proposed solar farm is located 4.2 miles southeast of the Imperial Valley Substation. It has the potential to interconnect to the Sunrise Powerlink at the CAISO controlled substation. The area is currently farmed, and no environmentally sensitive species have been found at the site. The project is bounded by undeveloped land on the west and agricultural land on the east and north. The All American Canal and the United States-Mexico border make up the southern boundary. The project location is shown in Figure 1.

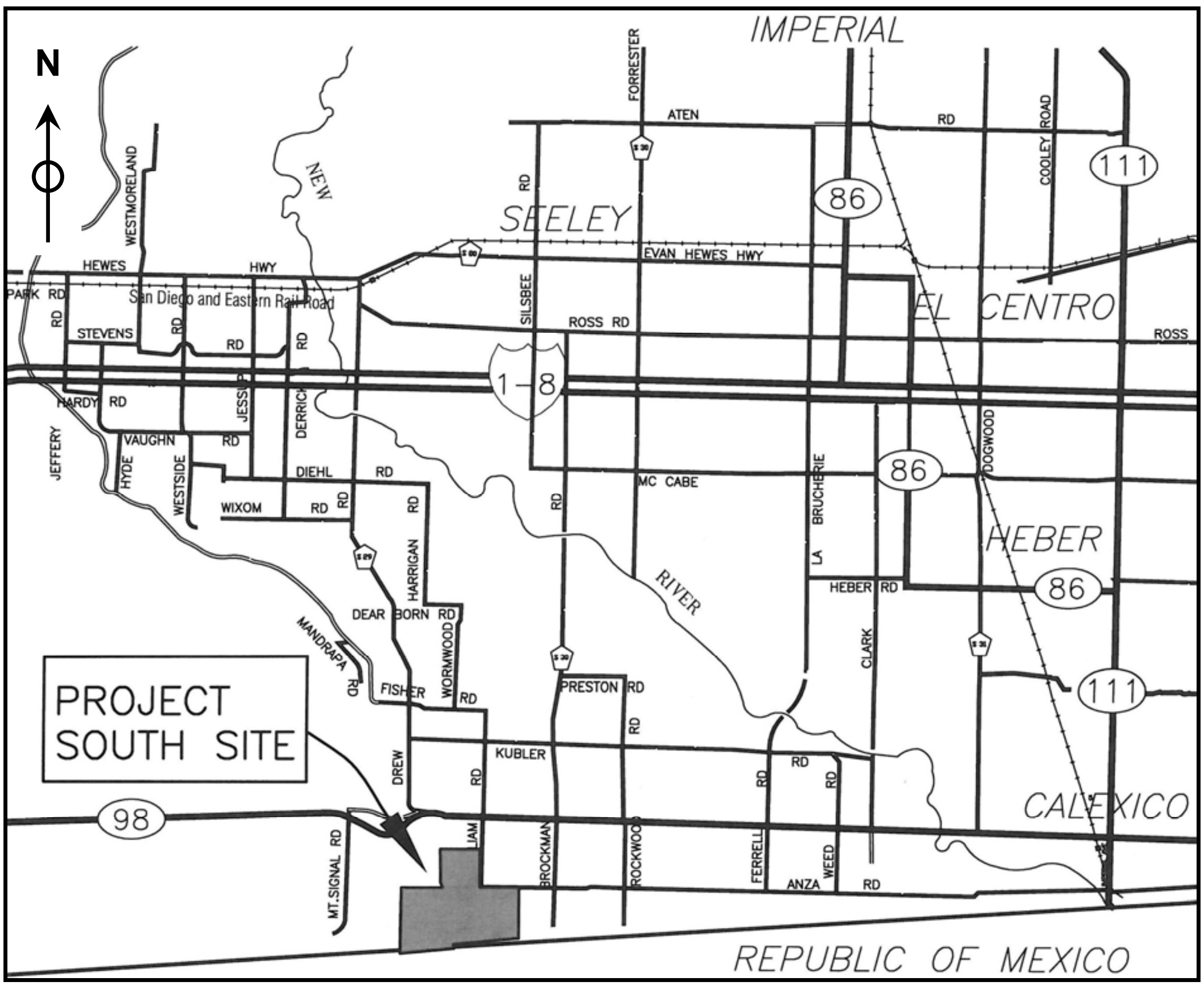


Figure 1 Project Location Map (No Scale)

2. Existing On-site Drainage Characteristics

Our preliminary review of the existing drainage patterns at the site indicates that onsite storm runoff ponds in many locations. The site topography indicates a generally flat slope, ranging from 0.2% to 0.40% in the agricultural fields. Fields on both the east and west sides of the Westside Main Canal generally drain to the northeast, with some minor variations depending on the existing drain systems. The overall site topography slopes generally northeasterly from the southwest corner, with the canal dividing the site. Irrigation ditches and culverts at the perimeter of many of the fields also convey runoff. The fields are used currently for agriculture and the existing drainage facilities are operational. The flat field slopes result in low flow velocities of storm runoff, which minimize the amount of sediment that is mobilized on the site. A detailed site survey will be made to determine the layout of the drainage system and the connections between the onsite system and the Imperial Irrigation District (IID) drains that bisect the project site. A review of the site and available topographic mapping indicates that runoff from many of the fields will pond at the low points and drain to downstream IID facilities for the existing condition. IID tile drain maps and a site visit indicate that several of the fields are underlain by agricultural tiles (See Figure 7).

3. <u>Offsite Drainage Considerations</u>

Offsite drainage patterns and tributary areas can be seen on Figure 3, entitled "Offsite Hydrology Map". A tributary drainage area of approximately 1,450 acres is found west of the site, with approximately 1,100 acres directed to the southwest corner of the site, and 350 acres to the northwest corner. An 80 acre-foot detention basin is proposed along the westerly boundary, which will detain runoff from offsite and onsite areas west of the Westside Main Canal.

Hydrograph runoff calculations for the offsite areas are provided in Appendix B. An overall runoff, storage, and outflow HEC-HMS calculation is also provided in Appendix B, along with a preliminary perimeter channel design for conveyance of these flows along the northerly boundary (west of the canal). The Offsite Drainage and Storage Analysis section of the report provides additional discussion. A review of FEMA floodplain maps indicated that there are no mapped floodplains on the project site.

4. <u>Objective and Drainage Design Approach</u>

The objective of this preliminary drainage study is to provide a preliminary analysis of the drainage impacts of the Solar South project, including analyzing offsite runoff that could affect the site. In addition, onsite runoff for both existing and proposed project conditions are compared with a hydrograph analysis. The onsite runoff analysis will show that the proposed condition runoff for the project will replicate existing peak flow rates. Figure 4, entitled "Onsite Hydrology Map" provides illustration for the onsite areas and flow paths.

<u>West of Westside Main Canal</u>

The offsite runoff tributary to the westerly portion of the site is proposed to be intercepted and collected at the boundary. An approximately 23-acre triangular-shaped area of land will be provided for detention. With an average depth of 4 feet, the detention basis provides approximately 80 acre-feet of storage. In combination with the existing Mt. Signal Drain #3 and the proposed northerly perimeter channel, a total of 86 acre-feet of storage is achieved. All runoff from areas west of the canal ends up at the northeast corner of the west half of the site; at that location, the Mt. Signal Drain #3 (channel) crosses under the existing canal through a 30" storm drain, which controls the outflow for the west half hydrograph and storage analysis. Attenuation of peak 100-year combined onsite and offsite flows (west half of site) will be achieved with the storage volume in the detention basin and in the channel areas. Figure 5 illustrates these concepts, with additional discussion provided in the Offsite Drainage and Storage section of the report.

East of Westside Main Canal

There is no offsite runoff tributary to the site areas east of the Westside Main Canal. The majority of the field areas drain northeasterly, with the westerly field area containing a portion that drains northwesterly. Onsite runoff will be stored with a combination of onsite minor ponding through curbing, and also some perimeter detention areas, as shown on Figure 6. It should be noted that while runoff generated from the proposed solar use will actually be less than existing runoff volumes (due to antecedent moisture conditions), the detention basins on the east side are provided such that the combination of onsite shallow ponding and detention basins could potentially store the entire proposed runoff hydrograph volume.

5. Proposed Solar South Improvements

Photovoltaic solar panels will be constructed at the site. A typical or potential layout for the panel blocks is shown on Figure 2 below. Each block will also contain the necessary inverters and transformers, which will be constructed along the access roads that pass through the site. To minimize the project's impact, access roads will be constructed with pervious surfaces; actual material will be determined during final engineering. The site will have a single operations and maintenance facility located in the northwest corner of the southeasterly portion of the site, near the Westside Main Canal (see Figure 4). A retention basin will be used to contain the runoff from this facility; the analysis follows in Section 6.

The solar panels will be constructed on posts or beams, and the land beneath the panels will remain pervious. The panels will be constructed facing south and tilted at a 20º angle. The lower edge of the panels will be approximately 2 feet above the finished ground surface elevation. The solar technology for the site has not been determined, so details about the foundation design and panel dimensions are not available. Regardless of the panel technology selected for the site, there will not be an impact on site hydrology. Rain falling on the panels will run off at the drip-line at the lower end of the panels. This runoff will be dispersed as it flows across the pervious areas under the panels.

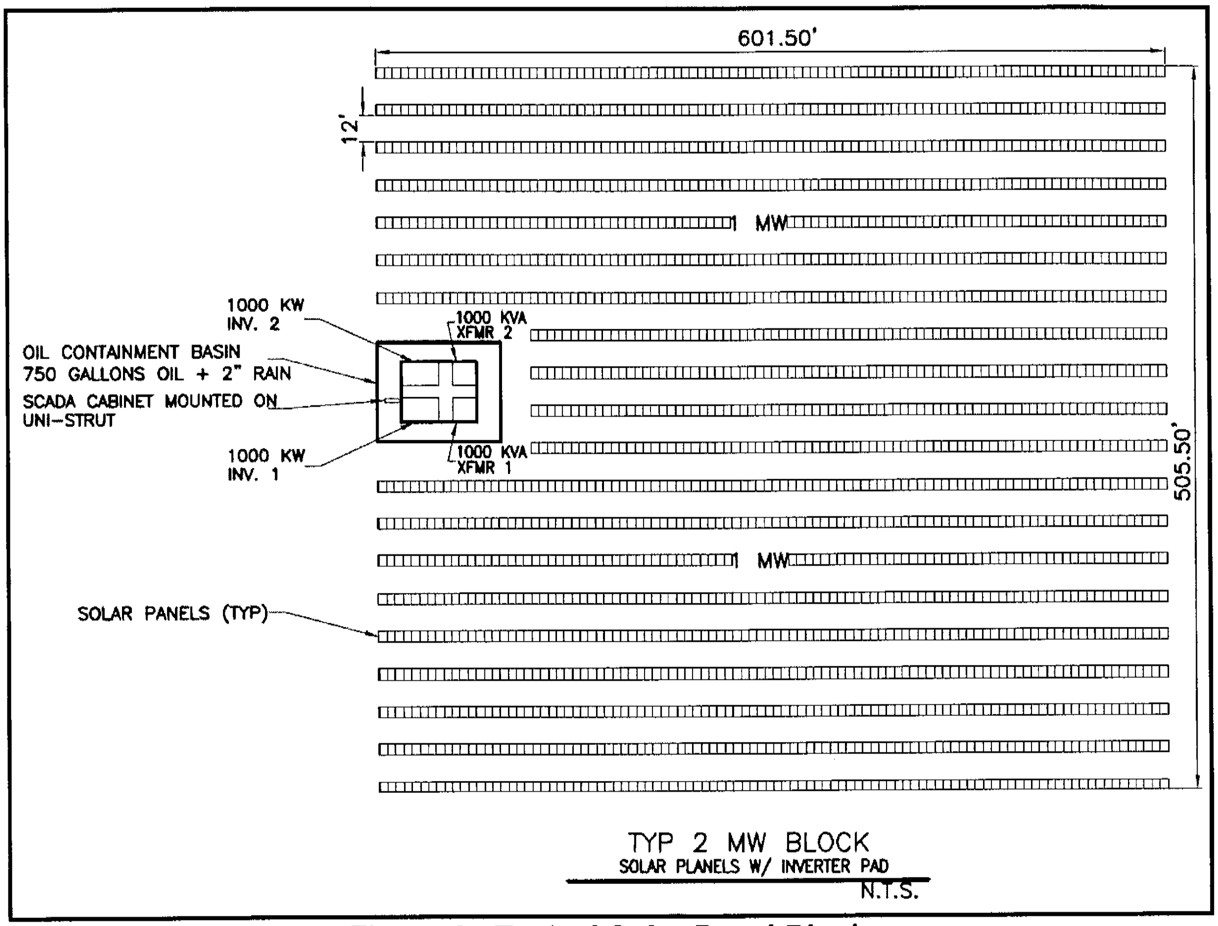


Figure 2 Typical Solar Panel Block

6. **Onsite Drainage Analysis**

Operations and Maintenance Facility Detention

The operations and maintenance area calculation results in a runoff volume of 7,310 cubic feet for the tributary area of 0.7 acres and a 3-inch precipitation. At the project final engineering stage, a design for that retention volume will be provided, with storage to be provided near the operations and maintenance facility to mitigate for the increase in runoff volume generated by the proposed impervious surfaces. An approximate basin size to obtain this retention volume is 65 feet square with a 2-foot depth.

Onsite Hydrology

The solar farm site was divided into fifteen subareas based on the field breaks at the site, with seven subareas west of the Westside Main Canal and 8 subareas to the east. The existing field slopes range from 0.25% to 0.4%, (0.35% typ.) for the majority of the field areas. These generally-flat slopes across the site can be utilized to pond water beneath the solar panels.

Hydrograph analyses have been performed for the areas noted above, divided into areas as follows: S1 through S-7, S8 and S9, S10 and S13-15, and S11 and S12. The hydrograph analysis was performed using the Hydraflow Hydrographs Extension for AutoCAD(R) Civil 3D(R) 2010 by Autodesk, Inc. v9.25. The SCS unit hydrograph was used with the software to generate the flows and volumes with input parameters noted below.

Input Parameters

Design Storm – Unit Hydrograph calculations were prepared using the SCS Method 24-hour storm and a 100-year return period. The Hydraflow Hydrographs Extension for AutoCAD Civil 3D was used to prepare the calculations.

Land Uses – Existing land use for the onsite areas is agricultural land. Proposed land use will be similar, since the site will be disturbed as little as possible to construct the solar farm. Land underneath the panels will remain pervious and the access roads will also be pervious surfaces. The only proposed impervious areas are the transformer pads within the solar panel blocks and the operations and maintenance facilities.

Soil Type – A site-specific soils map was obtained from the NRCS Web Soil Survey. Hydrologic Soil Groups at the site range from A to C.

Runoff Coefficient – In accordance with Figure C-2 in Appendix A, runoff curve numbers are based on land use and soil type.

Precipitation – The rainfall intensity-duration-frequency curve and design precipitation depths was obtained from NOAA Atlas 14. Data from the NOAA website, obtained for the project site's coordinates, are attached.

Time of Concentration – Times of concentration for the preliminary hydrograph analyses were determined using the Kirpich Equation.

Table 1 Summary of Areas and Hydrograph Results

Subarea	Area (ac)	Existing Peak (cfs)	Existing Volume (ac-ft)	Proposed Peak (cfs)	Proposed Volume (ac-ft)	Delta Peak (cfs)	Delta Volume (ac-ft)
S1 - S7	331	238	65	184	52	-54	-13
S11,S12	115	166	23	134	18	-32	-5
S10, S13-S15	300	434	65	368	54	-66	-11
S8,S9	155	267	33	227	28	-40	-5

Proposed condition drainage patterns will replicate existing conditions. Table 1 and the onsite hydrograph results in Appendix A show that the runoff peak flows and volumes generated by each onsite area will be reduced in the proposed developed condition. This is a result of the change in use from agriculture to solar. Year-round irrigated field crops and grasses have a higher antecedent moisture condition (AMC 3) than the proposed condition (AMC 2).

7. Proposed Drainage Infrastructure

The proposed solar panels will have a less than significant impact on peak flow rates and volumes, since the water that drains off of the panels will fall onto the pervious ground surface below the panels. Rain falling on the panels will run off at the drip-line at the lower end of the panels. This runoff will be dispersed as it flows across the pervious areas under the panels.

In the existing condition, runoff ponds throughout the site and then is drained to the IID drains through culverts and tile drains. In the proposed condition, culvert connections between the site and the IID drains will not be upsized. Therefore, the peak flow rates leaving the site are limited by the capacities of the existing culverts, and the combined attenuating effect with the perimeter detention storage is no increase in runoff.

Additionally, a conceptual storage design was developed to determine the available detention/retention volume under the solar panels with the provision of 6-inch curbs constructed at the lower end of the solar blocks. The conceptual onsite detention design is illustrated on Figure 6. As shown in this figure, the potential ponding depth would range from 0 to 6-inches in height with the typical cross slope of 0.35%. Also in Figure 6, it can be seen that for a 400 ft. by 300 ft. solar block area (block size not defined for Solar South at this time), the ponding area would reach 140 feet, or about 35% of the block area. By conservatively assuming up to 5% of that area is not available for shallow ponding, we have reduced this area to 30% in our calculations of available under-panel storage capacity. So, for a 100-acre area, 30 acres (30% of the area) with an average ponding depth of 0.25 ft., would provide up to 7.5 ac-ft of storage volume. That, in combination with the three detention basins on the easterly half of the project, is sufficient to contain the total runoff volume for onsite areas. The ultimate detention design will be determined at the final design stage of the project. The localized ponding under the panels can either infiltrate, based on the results of percolation tests, or drain through risers and tile drains to the discharge points.

Table 2 below lists the storage capacity volumes provided in both under-panel areas and in the three perimeter detention basins (east half of project only). The results show that the entire runoff hydrograph volumes can be stored with the combined capacity. Runoff hydrographs were generated for each onsite area and are found in Appendix A.

The final determination on the combination of under-panel and flat-graded basins will occur at final engineering. At that point in the design process, the solar panel technology and access road materials will be finalized.

Table 2 Solar South Runoff Storage Volumes (East of Westside Main Canal)

Area	Approx. Panel Area (ac)	Total Runoff (ac-ft)	Under-Panel Storage (ac-ft)	Detention Basin Area (ac)	Detention Basin Storage (ac-ft)	Excess Runoff (ac-ft)
S8,S9	130	28	10	4.5	18	0
S10, S13-S14	248	55	19	9	36	0
S11,S12	115	18	7	3	11	0

* 4-foot depth

8. Offsite Drainage and Storage Analysis West of Canal

Tributary drainage areas west of the site are indicated on Figure 3. Runoff from the west will enter the site and be intercepted and collected at the westerly boundary. 100-year storm runoff volumes and flows from the offsite areas are estimated using the US Army Corps of Engineers' HEC-HMS, Version 3.3.0. The analysis utilizes the SCS hydrograph method, NOAA Atlas 14 precipitation data, and the same input parameters noted for the onsite hydrographs. Calculations and backup input data are found in Appendix B.

We have also analyzed the combined effect of offsite and onsite runoff west of the Westside Main Canal, accounting for storage of the 100-year peak flows in the detention basin, northerly channel and Mt. Signal Drain #3. The purpose of this analysis is to show that the proposed project will greatly reduce the impact of offsite flows on IID's existing infrastructure, by attenuating offsite and onsite flows. The result will be that the existing 30-inch storm drain outlet will be able to accommodate all the flows.

The preliminary design for accommodating offsite flows consists of the perimeter detention basin at the westerly boundary, a graded trapezoidal channel along the northerly site perimeter, and the additional storage provided in the channels. The model was prepared using a stage-discharge relationship wit the 30" storm drain outlet. The stage-storage relationship was calculated using existing topography in the Mt. Signal Drain #3 and the proposed detention basin contours.

9. Discussion of CEQA Items

CEQA guidelines include hydrology and water quality items to be addressed. The 2009 California Environmental Equality Act Statues and Guidelines lists these items in Appendix G, sections VIII and XVI. Those items and the anticipated project impact level, are included in Table 3. A brief justification for the findings is also included in the table.

Table 3 CEQA Discussion Items

Item	Would the Project:	Significant Impact?
A (Sec. VIII)	Violate any water quality standards or waste discharge requirements?	No
	See Water Quality Report for this item.	
B	Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level?	No
	Site will only have a very minor increase in imperviousness and will not interfere substantially with recharge. Offsite water will be brought in for O&M. Ground water will not be pumped at the site.	
C	Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	No
	Onsite drainage will be designed to replicate the existing condition. Offsite flows will be handled in similar fashion to existing condition.	
D	Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	No
	Site will maintain all existing condition points of discharge.	
E	Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	No
	Existing condition peak flow rates will be replicated or reduced.	
F	Otherwise substantially degrade water quality?	No
	See Water Quality Report for this item.	
G	Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	No
	Proposed project will not increase floodplain elevations and no housing is located along the flow path between the site and the Westside Main Canal.	

H	The proposed transmission towers and panel supports will not impede flood flows.	No
	Expose people or structures to a significant risk of loss, injury or death involving flooding, including flooding as a result of the failure of a levee or dam?	
I	This project has some small, insignificant berms, but does not have or include any levees or dams.	No
	Inundation by seiche, tsunami, or mudflow?	
J	These items are not a concern at the project site.	No
	Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	
C (Sec. XVI)	Construction of detention basin and perimeter channels enhances water quality and sediment control on site. No significant environmental effects anticipated.	No

10. Summary of Findings

This preliminary analysis establishes that offsite runoff west of the Solar South site can be attenuated and conveyed through existing drainage facilities and that the proposed project will replicate existing site drainage conditions both east and west of the Westside Main Canal. More detailed analyses will be performed at the final engineering stage of the project to the satisfaction of Imperial County, to demonstrate both of these stated conditions once more.

11. Appendices

Appendix A. Onsite Hydrograph Calculations

Curve [1] Numbers of Hydrologic Soil-Cover Complexes for Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Ref. No. 21) (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Ref. No. 21)	Poor	53	70	80	85
(Manzonita, ceanothus and scrub oak)	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Ref. No. 21)	Poor	71	82	88	91
(Chamise and Redskank)	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadows or Seasonal Wetlands (Ref. No. 21)	Poor	63	77	85	88
(Areas with seasonally high water	Fair	51	70	80	84
table, principal vegetation is sod forming grass)	Good	30	58	72	78
Open Brush (Ref. No. 21)	Poor	62	76	84	88
(Soft wood shrubs-buckwheat, sage, etc.)	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (4)	Poor	45	66	77	83
(Coniferous or broadleaf trees	Fair	36	60	73	79
predominate. Canopy density is at least 50 percent)	Good	30	55	70	77
Woodland, Grass	Poor	57	73	82	86
(Coniferous or broadleaf trees with	Fair	43	65	76	82
canopy density from 20 to 50 percent)	Good	32	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawns, shrubs, etc.)	Good	39	61	74	80
Turf	Poor	68	79	86	89
(Irrigated and mowed grass)	Fair	49	69	79	84
	Good	39	61	74	80

REFERENCE NO. 32 UNLESS NOTED

CURVE NUMBERS FOR PERVIOUS AREAS

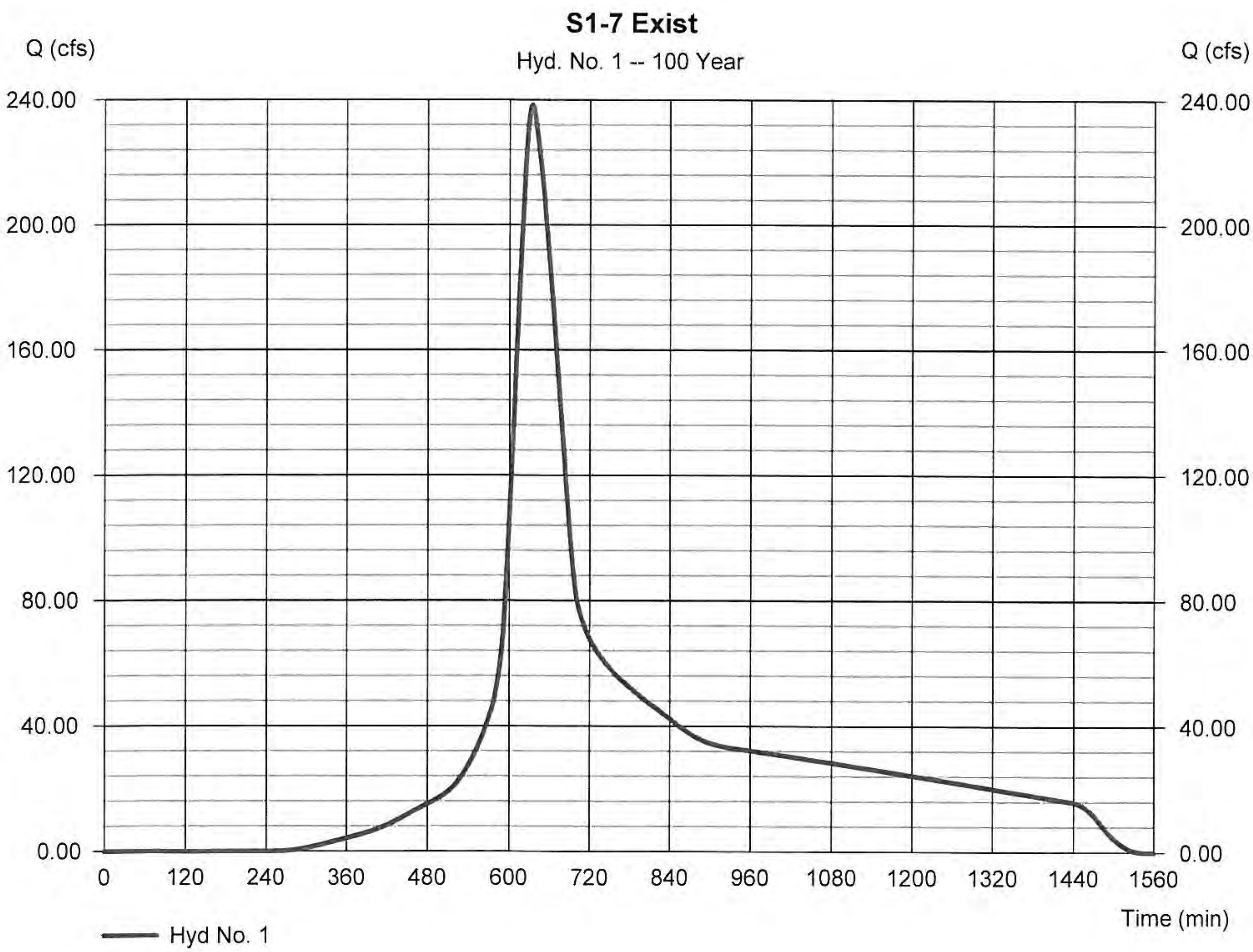
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Tuesday, Sep 14, 2010

Hyd. No. 1

S1-7 Exist

Hydrograph type	= SCS Runoff	Peak discharge	= 238.42 cfs
Storm frequency	= 100 yrs	Time to peak	= 634 min
Time interval	= 2 min	Hyd. volume	= 2,817,238 cuft
Drainage area	= 331.000 ac	Curve number	= 88.2
Basin Slope	= 0.2 %	Hydraulic length	= 4750 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 64.62 min
Total precip.	= 3.58 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



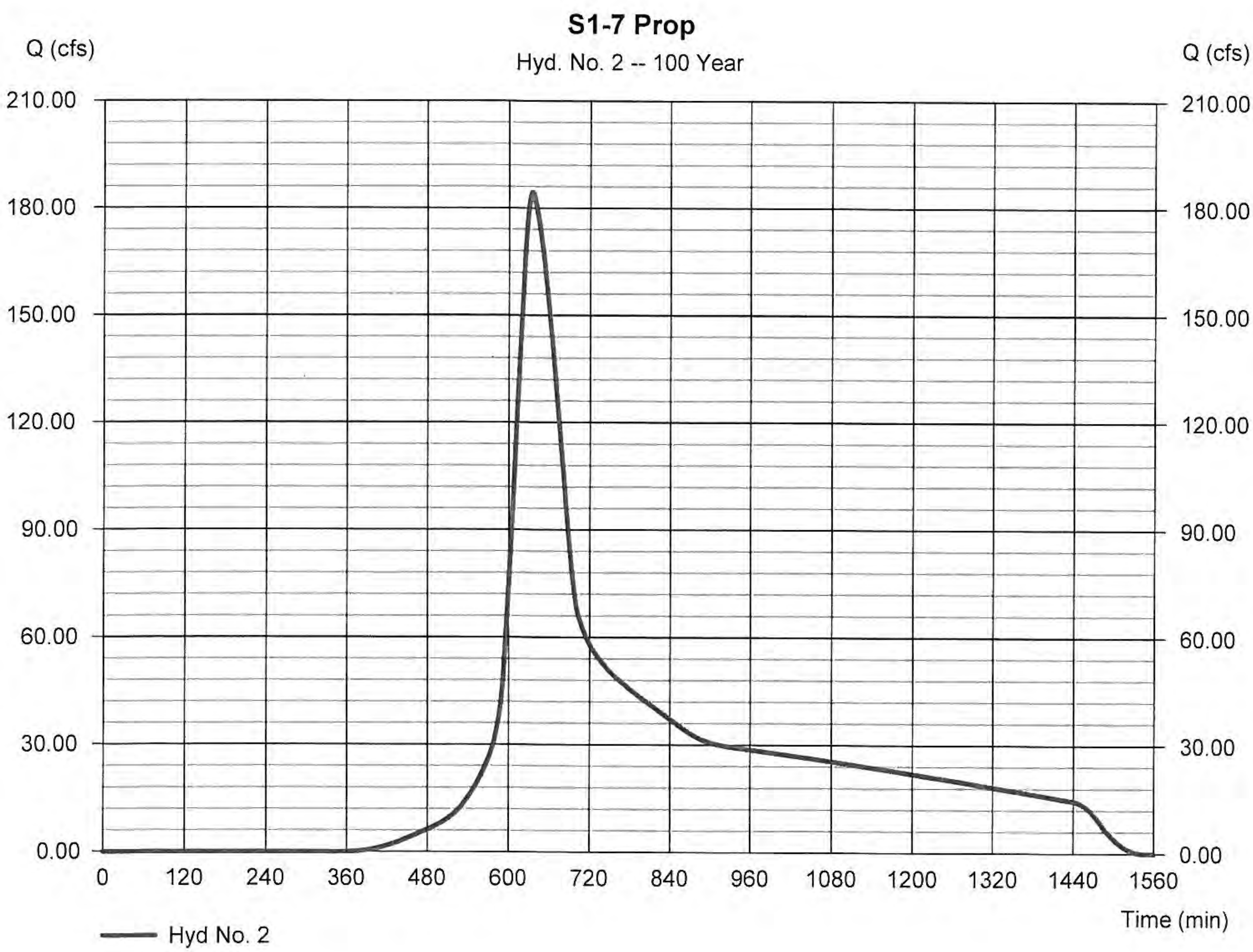
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Tuesday, Sep 14, 2010

Hyd. No. 2

S1-7 Prop

Hydrograph type	= SCS Runoff	Peak discharge	= 184.43 cfs
Storm frequency	= 100 yrs	Time to peak	= 634 min
Time interval	= 2 min	Hyd. volume	= 2,271,857 cuft
Drainage area	= 331.000 ac	Curve number	= 82.7
Basin Slope	= 0.2 %	Hydraulic length	= 4750 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 64.62 min
Total precip.	= 3.58 in	Distribution	= Type I
Storm duration	= 24 hrs	Shape factor	= 484



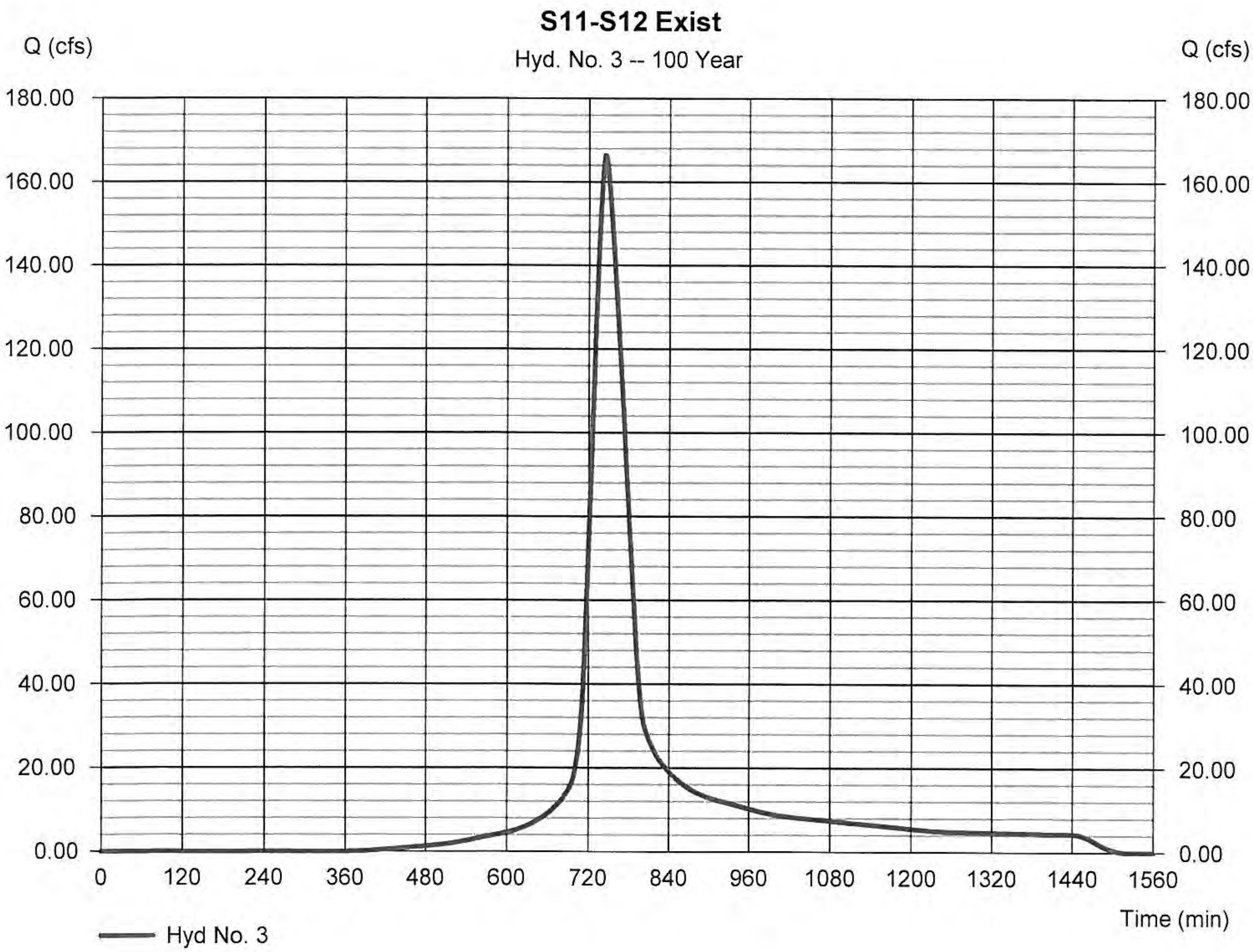
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 — Tuesday, Sep 14, 2010

Hyd. No. 3

S11-S12 Exist

Hydrograph type	= SCS Runoff	Peak discharge	= 166.35 cfs
Storm frequency	= 100 yrs	Time to peak	= 744 min
Time interval	= 2 min	Hyd. volume	= 992,650 cuft
Drainage area	= 115.000 ac	Curve number	= 88.2
Basin Slope	= 0.1 %	Hydraulic length	= 3140 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 52.94 min
Total precip.	= 3.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



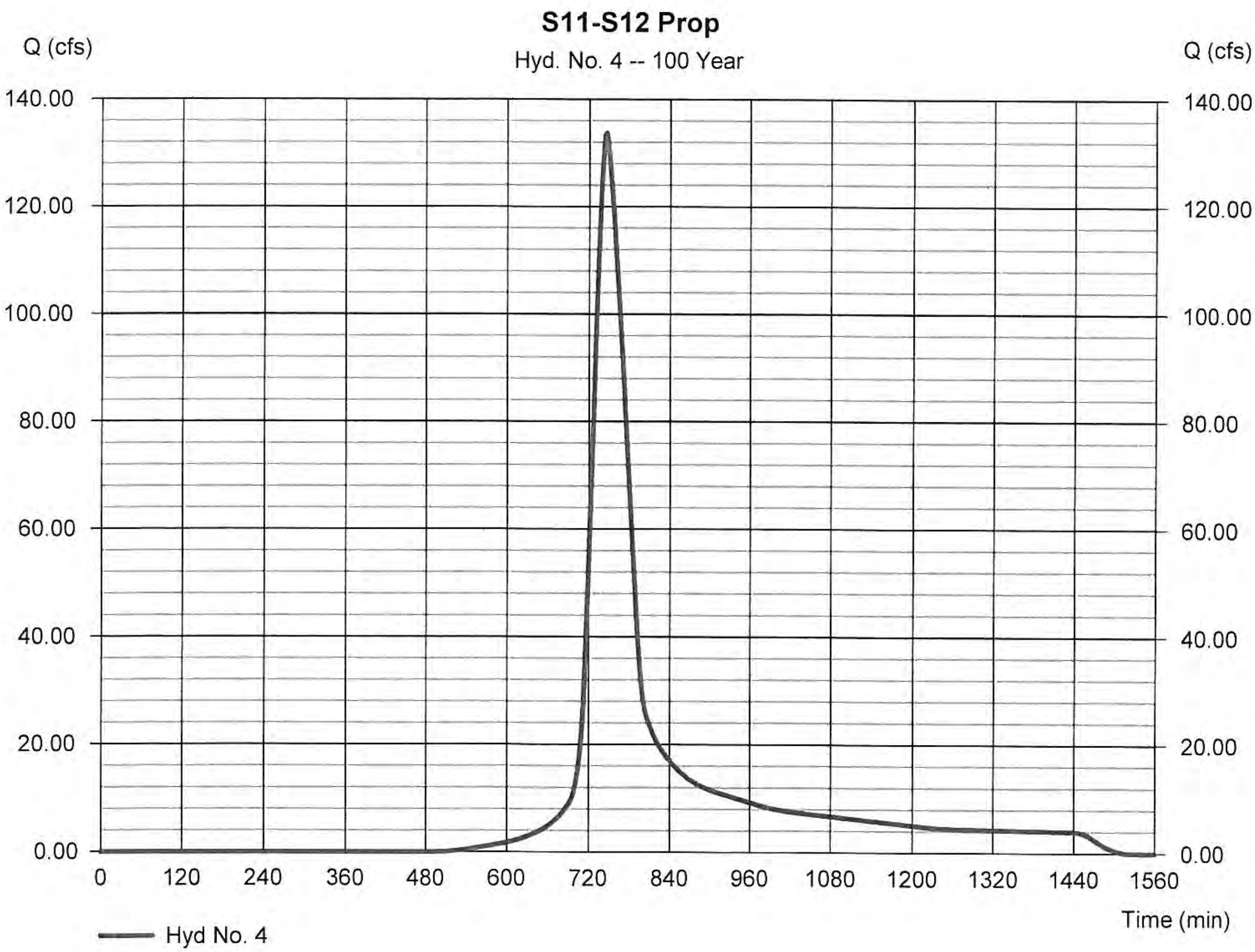
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Tuesday, Sep 14, 2010

Hyd. No. 4

S11-S12 Prop

Hydrograph type	= SCS Runoff	Peak discharge	= 133.74 cfs
Storm frequency	= 100 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 800,486 cuft
Drainage area	= 115.000 ac	Curve number	= 82.7
Basin Slope	= 0.1 %	Hydraulic length	= 3140 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 52.94 min
Total precip.	= 3.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



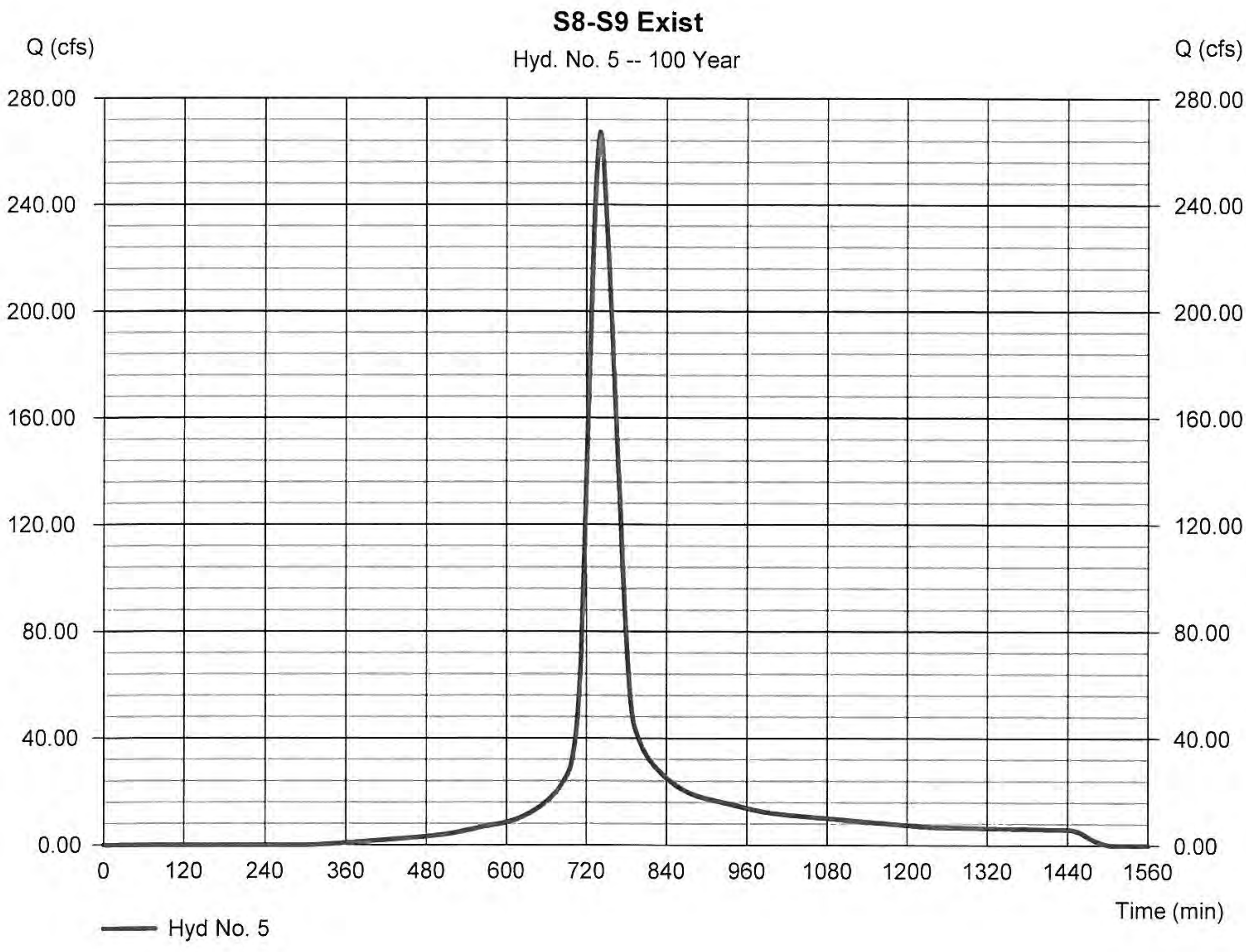
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 — Tuesday, Sep 14, 2010

Hyd. No. 5

S8-S9 Exist

Hydrograph type	= SCS Runoff	Peak discharge	= 267.27 cfs
Storm frequency	= 100 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 1,443,415 cuft
Drainage area	= 155.000 ac	Curve number	= 90.7
Basin Slope	= 0.2 %	Hydraulic length	= 3330 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 46.84 min
Total precip.	= 3.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484

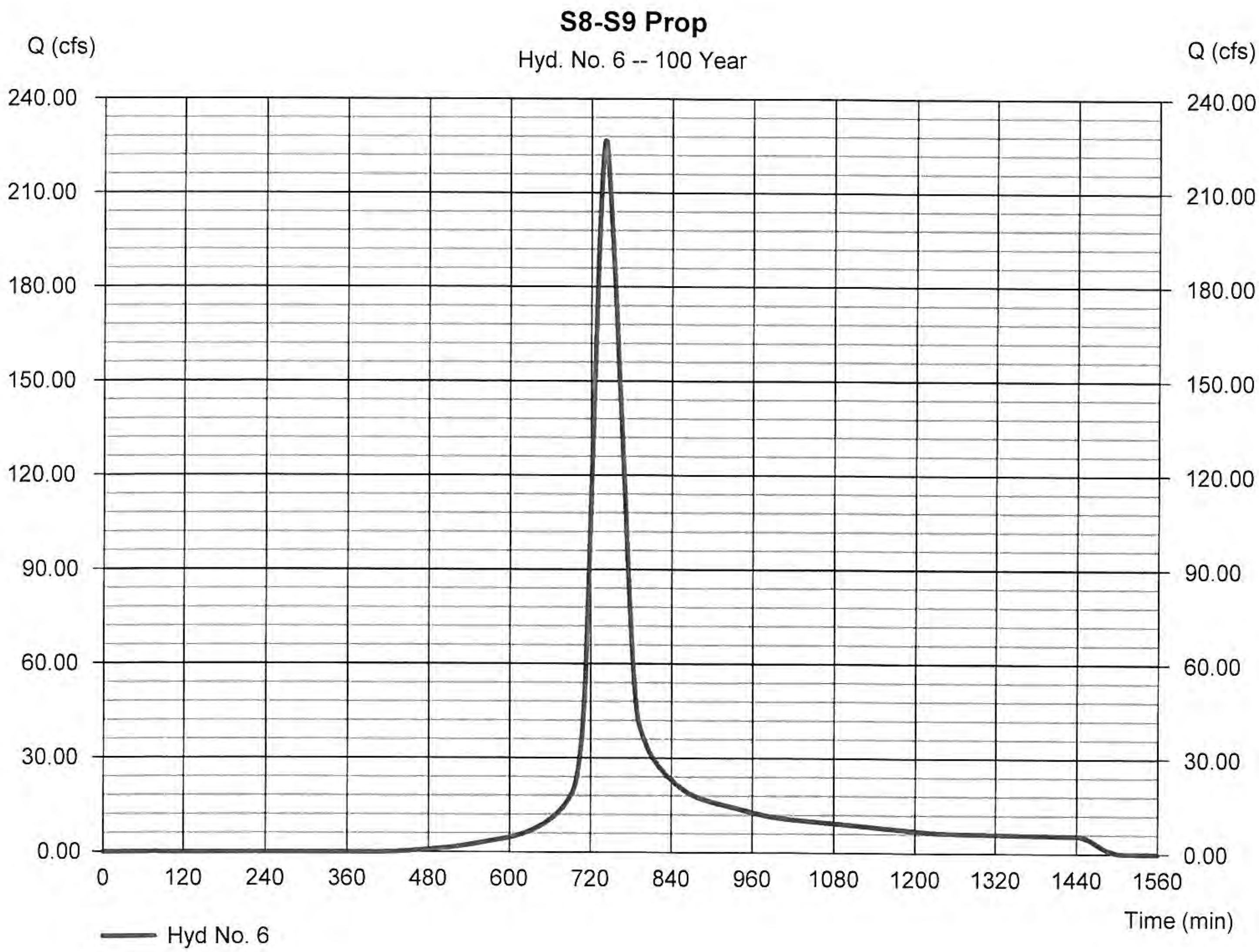


Hydrograph Report

Hyd. No. 6

S8-S9 Prop

Hydrograph type	= SCS Runoff	Peak discharge	= 226.67 cfs
Storm frequency	= 100 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 1,214,355 cuft
Drainage area	= 155.000 ac	Curve number	= 86.1
Basin Slope	= 0.2 %	Hydraulic length	= 3330 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 46.84 min
Total precip.	= 3.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



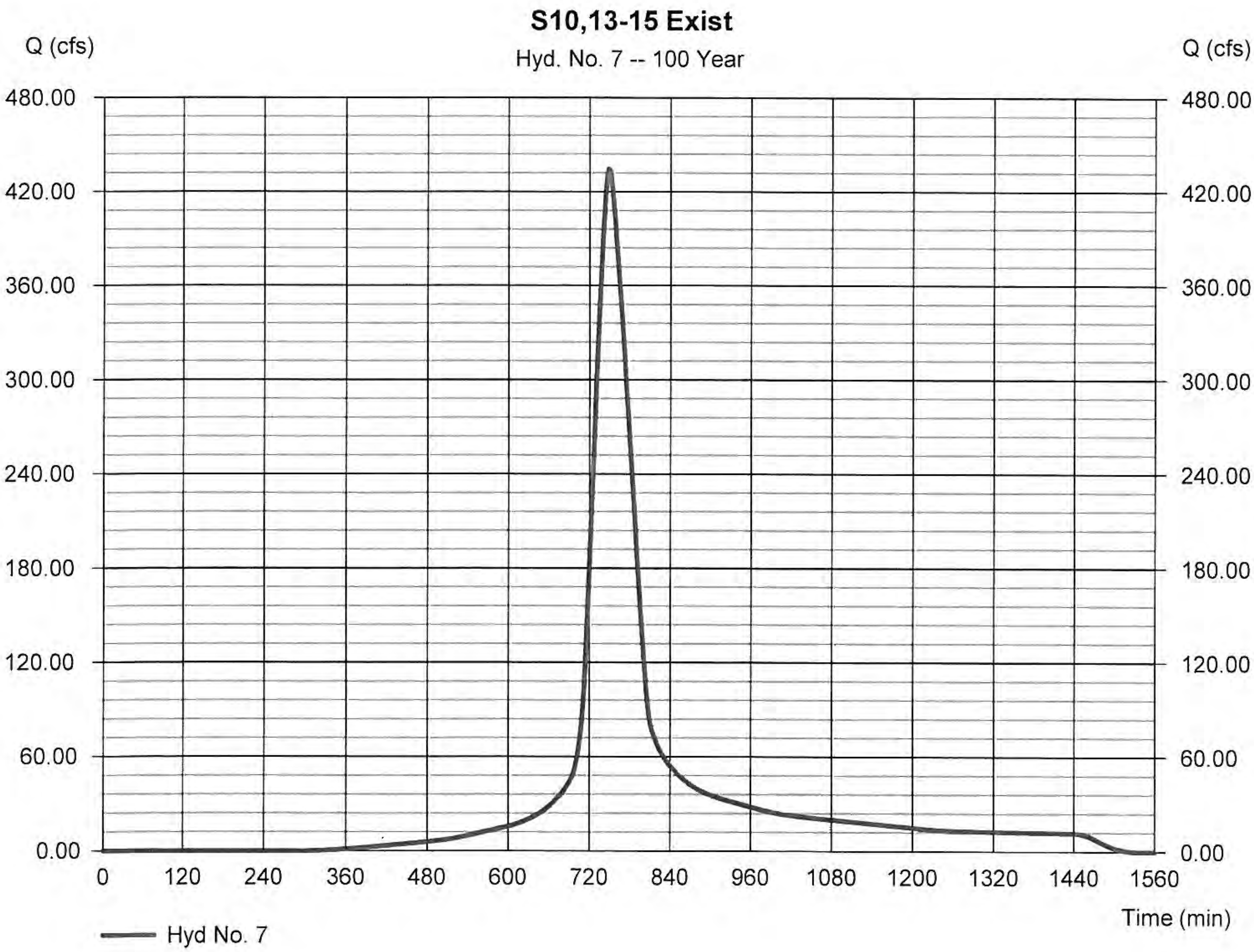
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Tuesday, Sep 14, 2010

Hyd. No. 7

S10,13-15 Exist

Hydrograph type	= SCS Runoff	Peak discharge	= 434.33 cfs
Storm frequency	= 100 yrs	Time to peak	= 748 min
Time interval	= 2 min	Hyd. volume	= 2,818,877 cuft
Drainage area	= 300.000 ac	Curve number	= 90.7
Basin Slope	= 0.1 %	Hydraulic length	= 3920 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 58.89 min
Total precip.	= 3.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



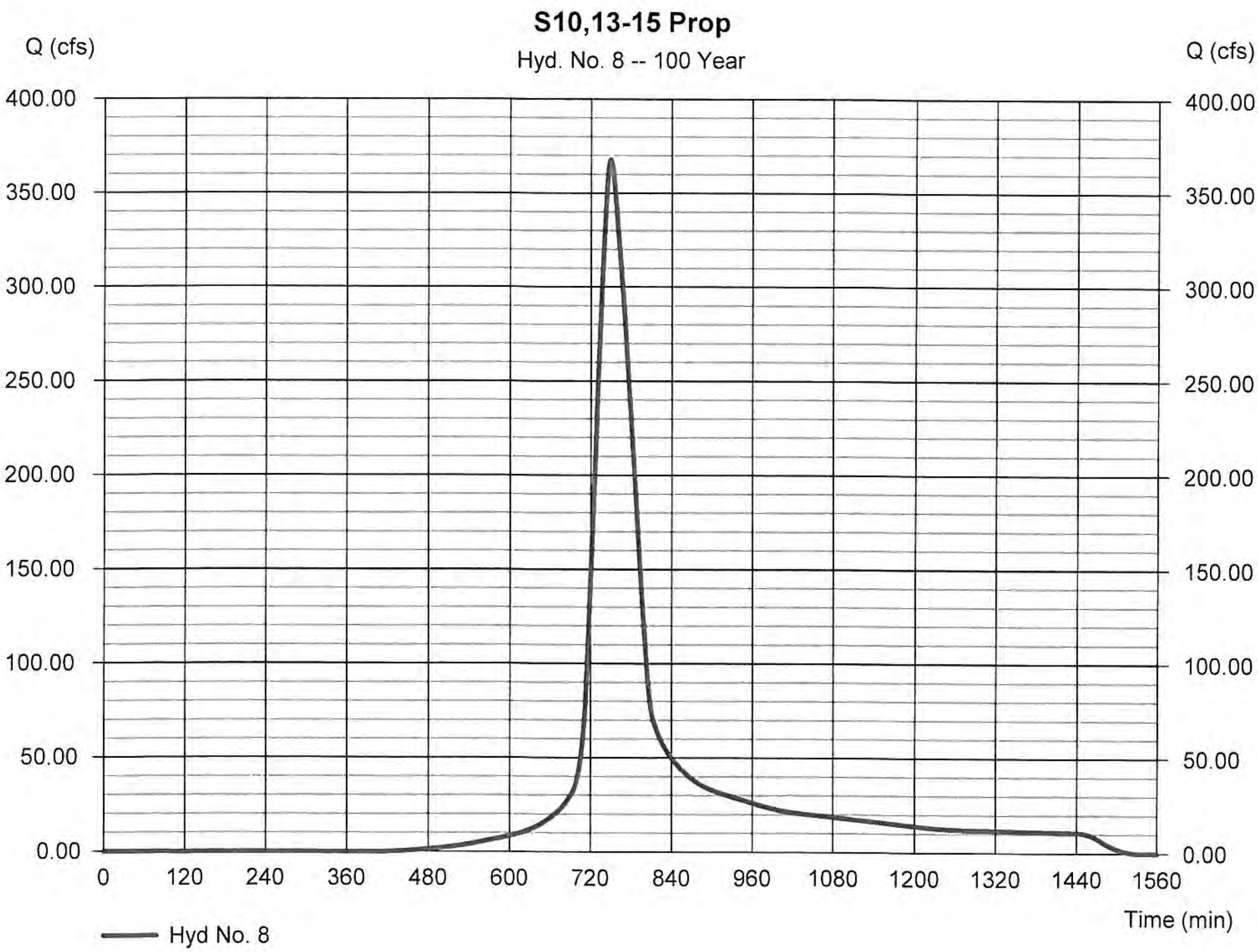
Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2010 by Autodesk, Inc. v9.25 Tuesday, Sep 14, 2010

Hyd. No. 8

S10,13-15 Prop

Hydrograph type	= SCS Runoff	Peak discharge	= 367.96 cfs
Storm frequency	= 100 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 2,371,542 cuft
Drainage area	= 300.000 ac	Curve number	= 86.1
Basin Slope	= 0.1 %	Hydraulic length	= 3920 ft
Tc method	= KIRPICH	Time of conc. (Tc)	= 58.89 min
Total precip.	= 3.58 in	Distribution	= Type II
Storm duration	= 24 hrs	Shape factor	= 484



Appendix B.

- **Offsite Hydrograph Calculations**
- **Perimeter Channel Calculations**

HEC-HMS

Project : SolarSouthHydrograph

Basin Model : Revised-Site

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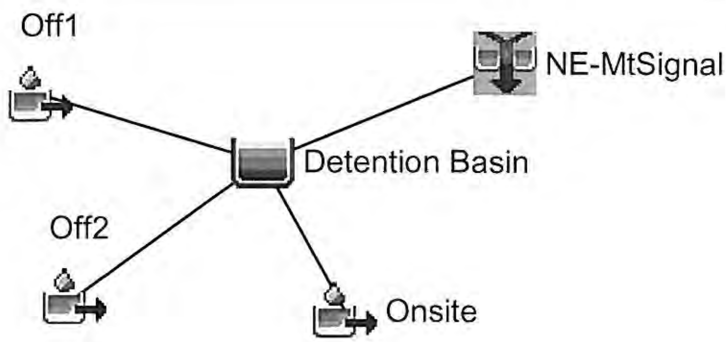


TORY R. WALKER ENGINEERING, INC.

Project	Solar South	**Date**	9/10/10	**By**	**JD**
Client	LightSource	**Checked**		**By**	
Subject	Offsite Runoff Flows and Volumes	**Approved**		**By**	

Offsite Basin 2

RUNOFF INDEX NUMBER (from County Hydrology Manual) BASIN 2 -Offsite

Natural = 62 Open Brush poor - Soil A
88 Open Brush poor - Soil C

note 400 acres ~ @ upper portion of basin, mountanous soil D

EXIST

LAND USE	AREA (ac)	SOIL	RI
Open	700.00	A	62
Open	400.00	D	88
TOTAL PERV.	1100.0		$\boxed{71.5}$ (avg)
IMPERVIOUS	0.0	---	98
TOTAL AREA =	1100.00 acres		$\boxed{71.5}$
=	1.7188 sq. mi.		

CN (72)

from Plate E-6.2, Fp = 0.34 in/hr
then for % impervious = 0.000 , **F = 0.340**

Total Imperviousness = 0%
Low-loss coefficient = $\boxed{90\%}$

Lag time;

Tc : t_{c1} = (Δelev ≅ 1600' in ~7,000' length)
t_{c1} ≅ 11 min (kirpich)

t_{c2} overland flow ≈ 1 mile wash
Q ≅ 150 CFS elev. 250 - 50
V ≅ 8 FPS t_2 = 11 min

t_{c3} storage in exist gravel pit ≈ 2 AC-FT
≅ 5 min

t_{c4} = sheet flow ≈ 3,500' 1.2 % Q ≅ 350 CFS
V ≅ 2.7 FPS t = 21 min

tc tot = 11 + 11 + 5 + 21 = 48 min
Lag = .8 (tc) = 38 min.

TORY R. WALKER ENGINEERING, INC.

Project	Solar South	**Date**	9/10/10	**By**	JD
Client	LightSource	**Checked**		**By**	
Subject	Offsite Runoff Flows and Volumes	**Approved**		**By**	

Offsite Basin 1

RUNOFF INDEX NUMBER (from County Hydrology Manual)

Offsite Basin 1
Hydrograph Input

Natural = 62 Open Brush poor - Soil A
88 Open Brush poor - Soil C

EXIST

LAND USE	AREA (ac)	SOIL	RI
Open	350.00	A	62
TOTAL PERV.	350.0		$\boxed{62.0}$ (avg)
IMPERVIOUS	0.0	---	98
TOTAL AREA =	350.00 acres		$\boxed{62.0}$
=	0.5469 sq. mi.		

CN

from Plate E-6.2, Fp = 0.45 in/hr

then for % impervious = 0.000 , **F = 0.450**

Total Imperviousness = 0%

Low-loss coefficient = $\boxed{90\%}$

Lag time:

$L = 8{,}000'$ $\Delta elev. = 240'$

Kirpich method $T_c \cong 31$ min.

$Lag = 0.8(T_c) = 24$ min

TORY R. WALKER ENGINEERING, INC.

Project	Solar South	**Date**	9/10/10	**By**	JD
Client	LightSource	**Checked**		**By**	
Subject	Onsite Runoff Flows and Volumes	**Approved**		**By**	

RUNOFF INDEX NUMBER (from County Hydrology Manual)

Onsite Hydrograph Input - Areas west of canal

Proposed	68	Annual grasses-poor	Soil A
	79	Annual grasses-poor	Soil B
	86	Annual grasses-poor	Soil C

Proposed

LAND USE	AREA (ac)	SOIL	RI	
Solar	40.0	A	68	
Solar	109.0	B	79	
Solar	182.0	C	86	
TOTAL PERV.	331.0		82	(avg)
IMPERVIOUS	0.0	---	98	
TOTAL AREA =	331.00 acres		82	
=	0.5172 sq. mi.			

from Plate E-6.2, Fp = 0.22 in/hr

then for % impervious = 0.000 , **F = 0.220**

Total Imperviousness = 0%

Low-loss coefficient = 90%

Lag time = 51 min
(tc = 62 min - from onsite 1-7 hydrographs)

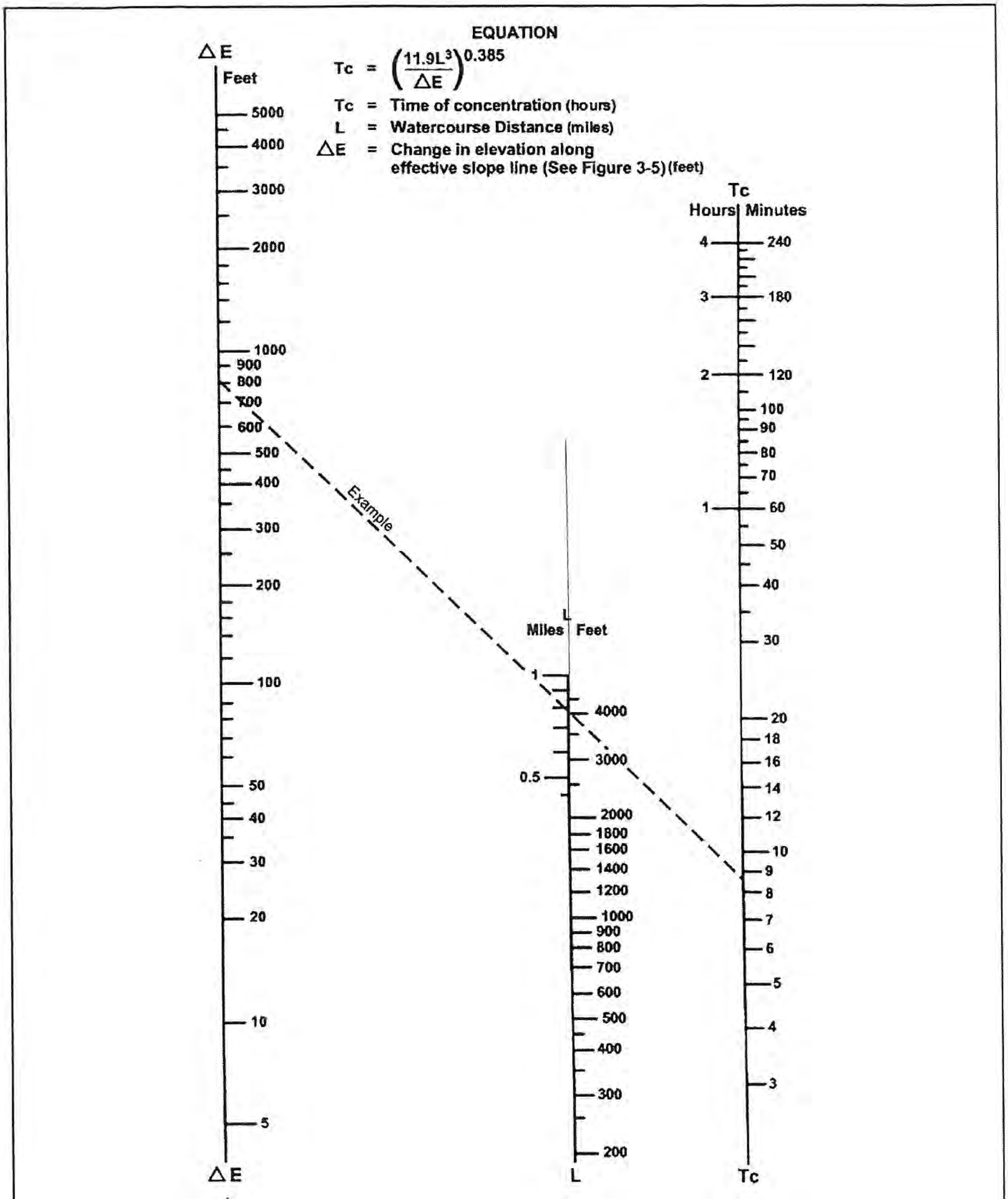
Curve [1] Numbers of Hydrologic Soil-Cover Complexes for Pervious Areas-AMC II

Cover Type (3)	Quality of Cover (2)	Soil Group A	B	C	D
NATURAL COVERS -					
Barren (Ref. No. 21) (Rockland, eroded and graded land)		78	86	91	93
Chaparral, Broadleaf (Ref. No. 21)	Poor	53	70	80	85
(Manzonita, ceanothus and scrub oak)	Fair	40	63	75	81
	Good	31	57	71	78
Chaparral, Narrowleaf (Ref. No. 21)	Poor	71	82	88	91
(Chamise and Redskank)	Fair	55	72	81	86
Grass, Annual or Perennial	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadows or Seasonal Wetlands (Ref. No. 21)	Poor	63	77	85	88
(Areas with seasonally high water	Fair	51	70	80	84
table, principal vegetation is sod forming grass)	Good	30	58	72	78
Open Brush (Ref. No. 21)	Poor	62	76	84	88
(Soft wood shrubs-buckwheat, sage, etc.)	Fair	46	66	77	83
	Good	41	63	75	81
Woodland (4)	Poor	45	66	77	83
(Coniferous or broadleaf trees	Fair	36	60	73	79
predominate. Canopy density is at least 50 percent)	Good	30	55	70	77
Woodland, Grass	Poor	57	73	82	86
(Coniferous or broadleaf trees with	Fair	43	65	76	82
canopy density from 20 to 50 percent)	Good	32	58	72	79
URBAN COVERS -					
Residential or Commercial Landscaping (Lawns, shrubs, etc.)	Good	39	61	74	80
Turf	Poor	68	79	86	89
(Irrigated and mowed grass)	Fair	49	69	79	84
	Good	39	61	74	80

REFERENCE NO. 32 UNLESS NOTED

CURVE NUMBERS FOR PERVIOUS AREAS

FIGURE C-2 (1 of 3)



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE

3-4

Nomograph for Determination of Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

POINT PRECIPITATION FREQUENCY ESTIMATES FROM NOAA ATLAS 14

California 32.658590 N 115.671183 W -13 feet

from "Precipitation-Frequency Atlas of the United States" NOAA Atlas 14, Volume 1, Version 4
G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland, 2006

Extracted: Mon Aug 30 2010

Precipitation Frequency Estimates (inches)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.11	0.16	0.20	0.27	0.34	0.43	0.49	0.60	0.69	0.76	0.78	0.80	0.84	0.86	0.94	1.02	1.13	1.21
2	0.14	0.22	0.27	0.37	0.46	0.59	0.66	0.81	0.93	1.03	1.06	1.10	1.15	1.19	1.29	1.41	1.56	1.67
5	0.23	0.34	0.42	0.57	0.71	0.91	1.01	1.22	1.39	1.55	1.62	1.67	1.73	1.80	1.97	2.13	2.36	2.54
10	0.29	0.45	0.55	0.75	0.92	1.20	1.31	1.55	1.74	1.96	2.07	2.12	2.20	2.29	2.50	2.69	2.96	3.19
25	0.41	0.62	0.77	1.03	1.28	1.63	1.76	2.03	2.25	2.56	2.74	2.80	2.87	2.98	3.25	3.46	3.78	4.10
50	0.51	0.78	0.96	1.29	1.60	2.03	2.15	2.44	2.67	3.04	3.31	3.37	3.42	3.57	3.86	4.09	4.43	4.82
100	~~0.63~~	~~0.96~~	~~1.19~~	~~1.60~~	~~1.98~~	~~2.48~~	~~2.60~~	~~2.89~~	~~3.42~~	$\boxed{3.58}$	3.94	4.00	4.03	4.20	4.52	4.75	5.11	5.58
200	0.77	1.17	1.46	1.96	2.43	3.00	3.11	3.40	3.62	4.16	4.65	4.71	4.76	4.90	5.23	5.46	5.82	6.37
500	1.00	1.52	1.88	2.54	3.14	3.83	3.95	4.20	4.35	5.00	5.71	5.75	5.81	5.92	6.25	6.47	6.79	7.47
1000	1.21	1.83	2.27	3.06	3.79	4.57	4.70	4.95	5.08	5.70	6.62	6.65	6.71	6.77	7.10	7.28	7.56	8.34

* These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

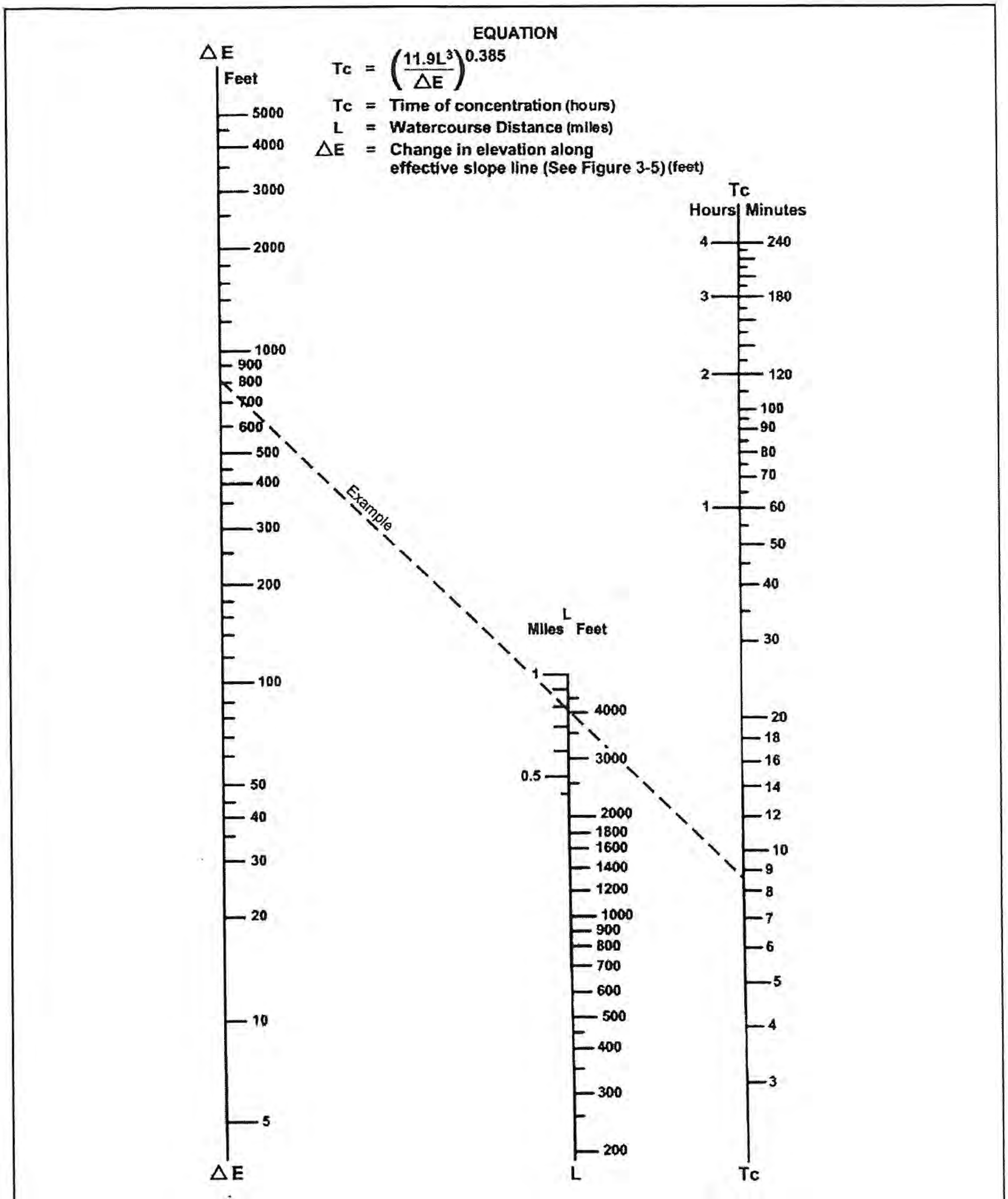
*** Upper bound of the 90% confidence interval Precipitation Frequency Estimates (inches)**

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.13	0.20	0.24	0.33	0.40	0.52	0.58	0.70	0.80	0.90	0.92	0.94	0.98	1.02	1.10	1.19	1.31	1.40
2	0.17	0.27	0.33	0.45	0.55	0.72	0.80	0.96	1.08	1.22	1.26	1.29	1.34	1.40	1.51	1.63	1.80	1.93
5	0.28	0.43	0.53	0.71	0.88	1.11	1.21	1.43	1.61	1.83	1.91	1.95	2.03	2.12	2.31	2.47	2.73	2.93
10	0.37	0.56	0.70	0.94	1.16	1.44	1.56	1.82	2.02	2.31	2.44	2.49	2.58	2.68	2.92	3.10	3.42	3.68
25	0.52	0.79	0.98	1.32	1.63	1.97	2.09	2.39	2.61	3.00	3.23	3.28	3.37	3.50	3.79	4.01	4.37	4.72
50	0.65	0.99	1.23	1.66	2.06	2.44	2.57	2.89	3.12	3.58	3.90	3.95	4.04	4.20	4.51	4.74	5.12	5.58
100	0.81	1.24	1.53	2.06	2.55	2.99	3.11	3.44	3.66	4.21	4.67	4.71	4.77	4.96	5.30	5.53	5.93	6.46
200	1.00	1.53	1.90	2.55	3.16	3.64	3.75	4.06	4.28	4.90	5.53	5.57	5.58	5.81	6.16	6.38	6.78	7.41
500	1.31	2.00	2.48	3.33	4.13	4.68	4.80	5.06	5.19	5.92	6.84	6.86	6.93	7.08	7.42	7.61	7.96	8.77
1000	1.61	2.44	3.03	4.08	5.05	5.65	5.79	6.04	6.12	6.78	7.98	8.01	8.09	8.17	8.51	8.62	8.92	9.85

* The **upper** bound of the confidence interval at 90% confidence level is the value which 5% of the simulated quantile values for a given frequency are **greater** than.
** These precipitation frequency estimates are based on a partial duration series. **ARI** is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting prevents estimates near zero to appear as zero.

*** Lower bound of the 90% confidence interval Precipitation Frequency Estimates (inches)**

ARI** (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.09	0.13	0.16	0.22	0.27	0.36	0.41	0.51	0.59	0.65	0.67	0.69	0.72	0.74	0.81	0.88	0.97	1.04



SOURCE: California Division of Highways (1941) and Kirpich (1940)

FIGURE **3-4**

Nomograph for Determination of Time of Concentration (Tc) or Travel Time (Tt) for Natural Watersheds

Basin Summaries

Project: SolarSouthHydrograph Simulation Run: Revised Site Plan Detention

Start of Run: 01Aug2010, 12:00 Basin Model: Revised-Site
End of Run: 03Aug2010, 12:00 Meteorologic Model: SCS-100-yr
Compute Time: 29Sep2010, 10:08:10 Control Specifications: 24-hour

Volume Units: AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
Detention Basin	2.787	77.8	02Aug2010, 09:54	177.7
NE-MtSignal	2.787	77.8	02Aug2010, 09:54	177.7
Off1	0.550	44.7	01Aug2010, 22:24	19.2
Off2	1.720	316.0	01Aug2010, 22:36	107.5
Onsite	0.517	151.0	01Aug2010, 22:48	51.0

Offsite Tributary Basin 1

Project: SolarSouthHydrograph

Simulation Run: Revised Site Plan Detention Subbasin: Off1

Start of Run:	01Aug2010, 12:00	Basin Model:	Revised-Site
End of Run:	03Aug2010, 12:00	Meteorologic Model:	SCS-100-yr
Compute Time:	20Sep2010, 15:06:51	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge :	44.7 (CFS)	Date/Time of Peak Discharge :	01Aug2010, 22:24
Total Precipitation :	105.0 (AC-FT)	Total Direct Runoff :	19.2 (AC-FT)
Total Loss :	85.8 (AC-FT)	Total Baseflow :	0.0 (AC-FT)
Total Excess :	19.2 (AC-FT)	Discharge :	19.2 (AC-FT)

Offsite Tributary Basin 2

Project: SolarSouthHydrograph

Simulation Run: Revised Site Plan Detention Subbasin: Off2

Start of Run:	01Aug2010, 12:00	Basin Model:	Revised-Site
End of Run:	03Aug2010, 12:00	Meteorologic Model:	SCS-100-yr
Compute Time:	20Sep2010, 15:06:51	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Discharge :	316.0 (CFS)	Date/Time of Peak Discharge :	01Aug2010, 22:36
Total Precipitation :	328.4 (AC-FT)	Total Direct Runoff :	107.5 (AC-FT)
Total Loss :	220.9 (AC-FT)	Total Baseflow :	0.0 (AC-FT)
Total Excess :	107.5 (AC-FT)	Discharge :	107.5 (AC-FT)

Detention Basin Summary

Project: SolarSouthHydrograph

Simulation Run: Revised Site Plan Detention Reservoir: Detention Basin

Start of Run:	01Aug2010, 12:00	Basin Model:	Revised-Site
End of Run:	03Aug2010, 12:00	Meteorologic Model:	SCS-100-yr
Compute Time:	29Sep2010, 10:08:10	Control Specifications:	24-hour

Volume Units: AC-FT

Computed Results

Peak Inflow :	499.0 (CFS)	Date/Time of Peak Inflow :	01Aug2010, 22:36
Peak Outflow :	77.8 (CFS)	Date/Time of Peak Outflow :	02Aug2010, 09:54
Total Inflow :	177.7 (AC-FT)	Peak Storage :	85.7 (AC-FT)
Total Outflow :	177.7 (AC-FT)	Peak Elevation :	92.9 (FT)

note ≅ 80 AC-FT storage in westerly detention basin

≃ 6 AC-FT storage in channels (including Mt. Signal #3)

Project: SolarSouthHydrograph

Simulation Run: Revised Site Plan Detention Subbasin: Onsite

Start of Run:	01Aug2010, 12:00	Basin Model:	Revised-Site
End of Run:	03Aug2010, 12:00	Meteorologic Model:	SCS-100-yr
Compute Time:	29Sep2010, 10:08:10	Control Specifications:	24-hour

Volume Units: AC-FT

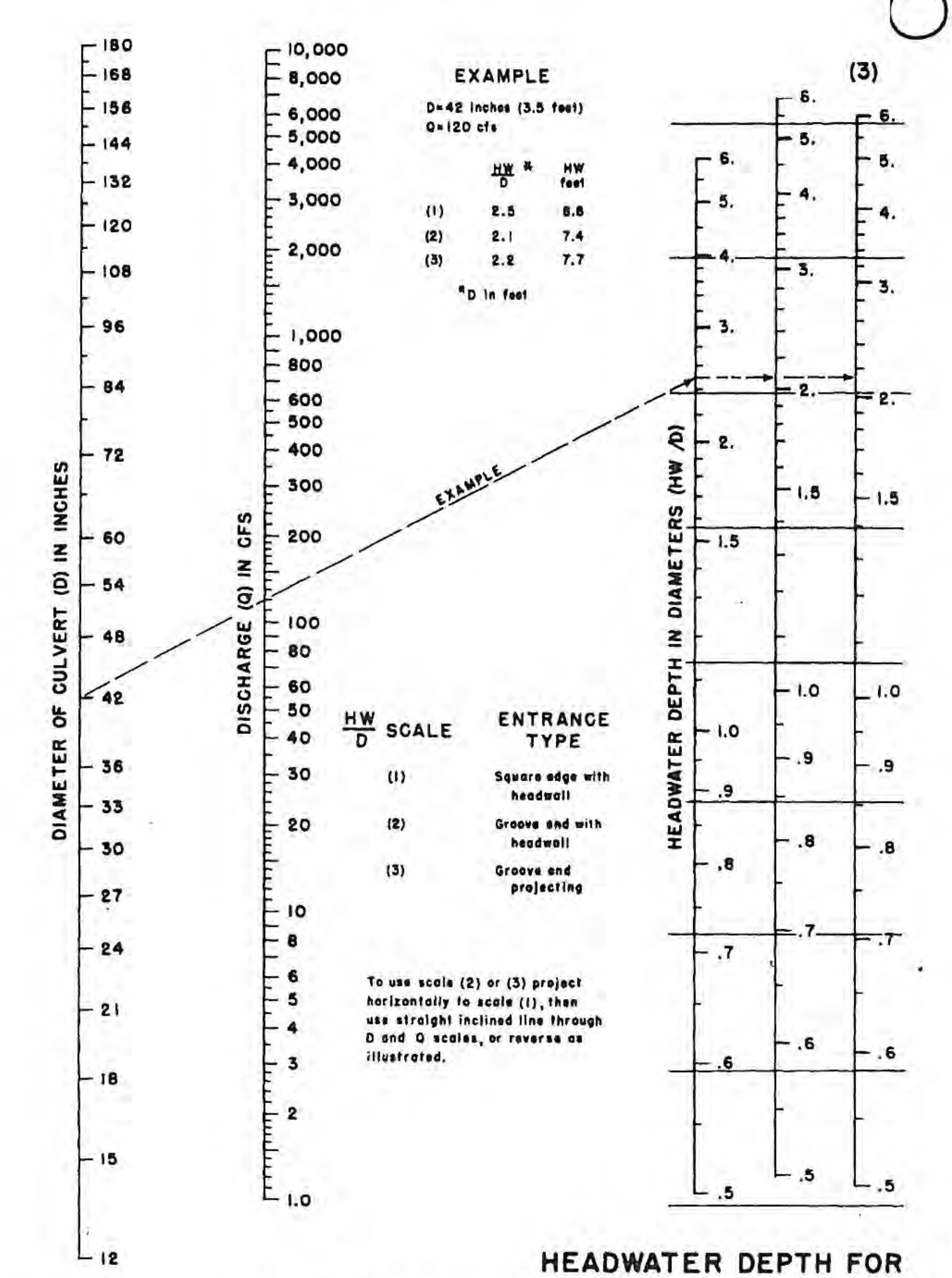
Computed Results

Peak Discharge :	151.0 (CFS)	Date/Time of Peak Discharge :	01Aug2010, 22:48
Total Precipitation :	98.7 (AC-FT)	Total Direct Runoff :	51.0 (AC-FT)
Total Loss :	47.8 (AC-FT)	Total Baseflow :	0.0 (AC-FT)
Total Excess :	51.0 (AC-FT)	Discharge :	51.0 (AC-FT)

Project	Solar South	Date	9/10/10	By	JD
Client	LightSource	Checked		By	
Subject	Stage-Storage-Elevation Values	Approved		By	

Elevation (FT)	Storage (AC-FT)	Outflow 30" (CFS)
81	0	0
82	0.01	5
83	0.15	16
84	0.2	29
85	0.3	38
86	0.4	45
87	1.5	52
88	2.6	58
89	3.7	62
90	26.1	67
91	49.1	70
92	70.6	74
93	94.6	80
94	118	86
95	441	88
96	500	90

CHART 1B



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3 REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

```
****************************************************************************
                HYDRAULIC ELEMENTS - I  PROGRAM PACKAGE
        (C) Copyright 1982-2007 Advanced Engineering Software (aes)
            Ver. 14.0  Release Date: 06/01/2007  License ID 1532

                         Analysis prepared by:
```

Northerly Channel Hydraulics

```
----------------------------------------------------------------------------
  TIME/DATE OF STUDY: 11:07 09/29/2010
============================================================================
 Problem Descriptions:
  NORTHERLY PERIMETER CHANNEL
  20' BOTTOM WIDTH

****************************************************************************
>>>>CHANNEL INPUT INFORMATION<<<<
----------------------------------------------------------------------------
    CHANNEL Z1(HORIZONTAL/VERTICAL) =    3.00
            Z2(HORIZONTAL/VERTICAL) =    3.00
    BASEWIDTH(FEET) =     20.00
    CONSTANT CHANNEL SLOPE(FEET/FEET) = 0.001000
    UNIFORM FLOW(CFS) =        77.80
    MANNINGS FRICTION FACTOR = 0.0300
============================================================================
    NORMAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------------
    >>>>> NORMAL DEPTH(FEET) =    1.64
    FLOW TOP-WIDTH(FEET) =          29.83
    FLOW AREA(SQUARE FEET) =            40.82
    HYDRAULIC DEPTH(FEET) =      1.37
    FLOW AVERAGE VELOCITY(FEET/SEC.) =      1.91
    UNIFORM FROUDE NUMBER =    0.287
    PRESSURE + MOMENTUM(POUNDS) =          2236.85
    AVERAGED VELOCITY HEAD(FEET) =      0.056
    SPECIFIC ENERGY(FEET) =       1.695
============================================================================
    CRITICAL-DEPTH FLOW INFORMATION:
----------------------------------------------------------------------------
    CRITICAL FLOW TOP-WIDTH(FEET) =          24.48
    CRITICAL FLOW AREA(SQUARE FEET) =            16.62
    CRITICAL FLOW HYDRAULIC DEPTH(FEET) =      0.68
    CRITICAL FLOW AVERAGE VELOCITY(FEET/SEC.) =      4.68
    CRITICAL DEPTH(FEET) =      0.75
    CRITICAL FLOW PRESSURE + MOMENTUM(POUNDS) =          1080.22
    AVERAGED CRITICAL FLOW VELOCITY HEAD(FEET) =      0.340
    CRITICAL FLOW SPECIFIC ENERGY(FEET) =       1.088
============================================================================
```

S = 0.1 %
20' bottom

DN

Additional Figures

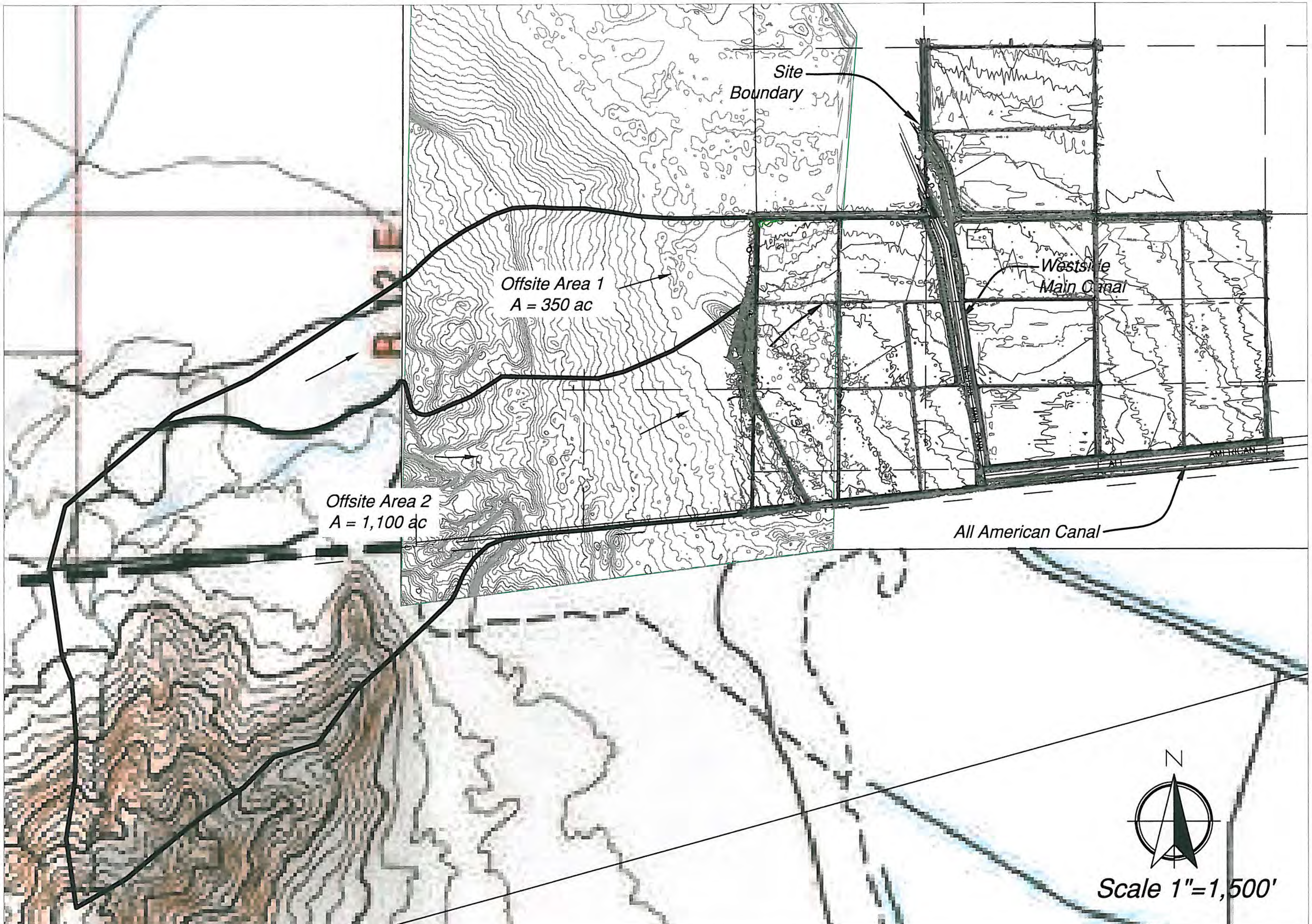


Figure 3: Imperial Valley South Solar Farm - Offsite Hydrology Map

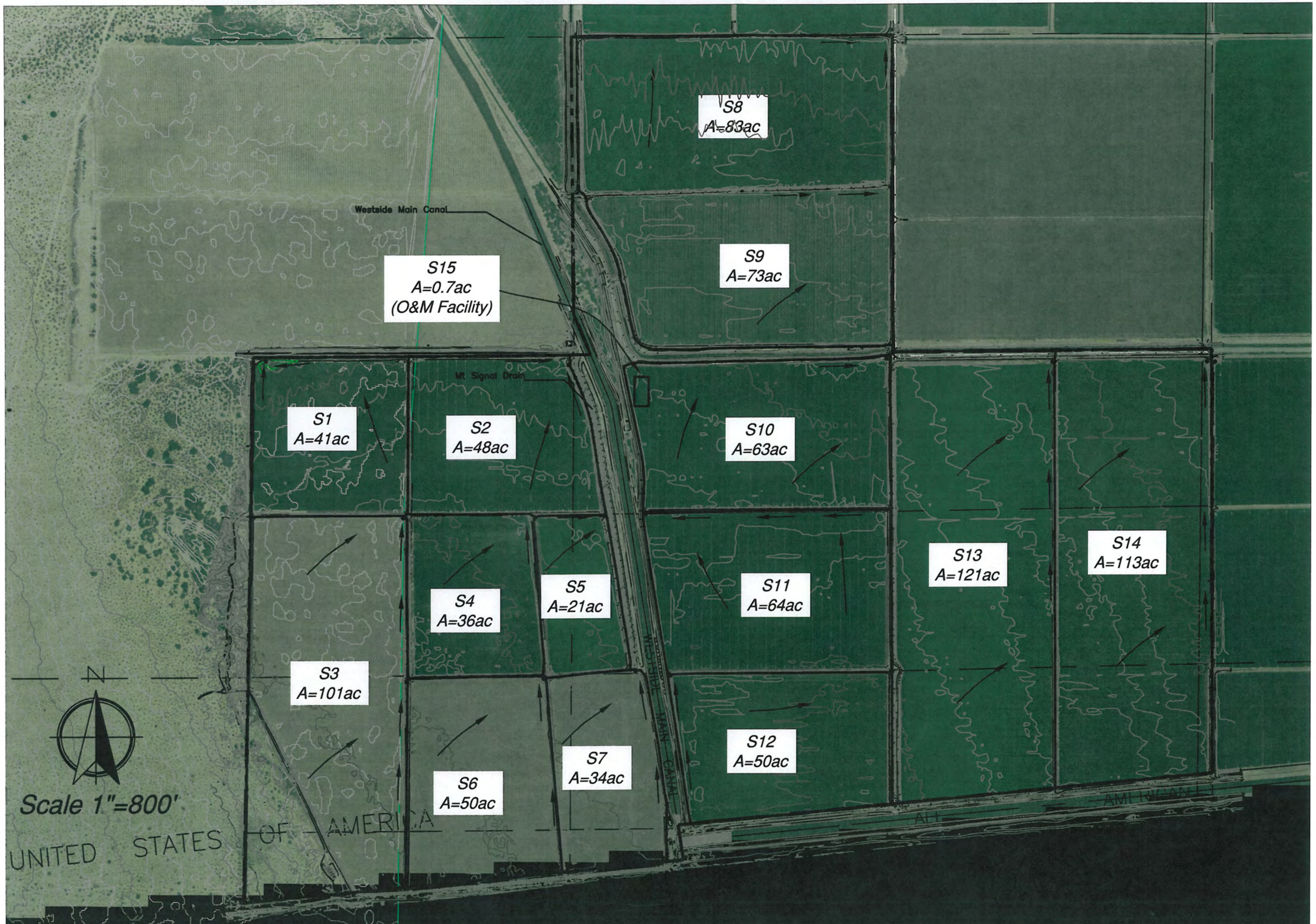


Figure 4: Imperial Valley South Solar Farm - Onsite Hydrology Map

Figure 5: Solar South Storage Exhibit

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WATER RESOURCES PLANNING & ENGINEERING

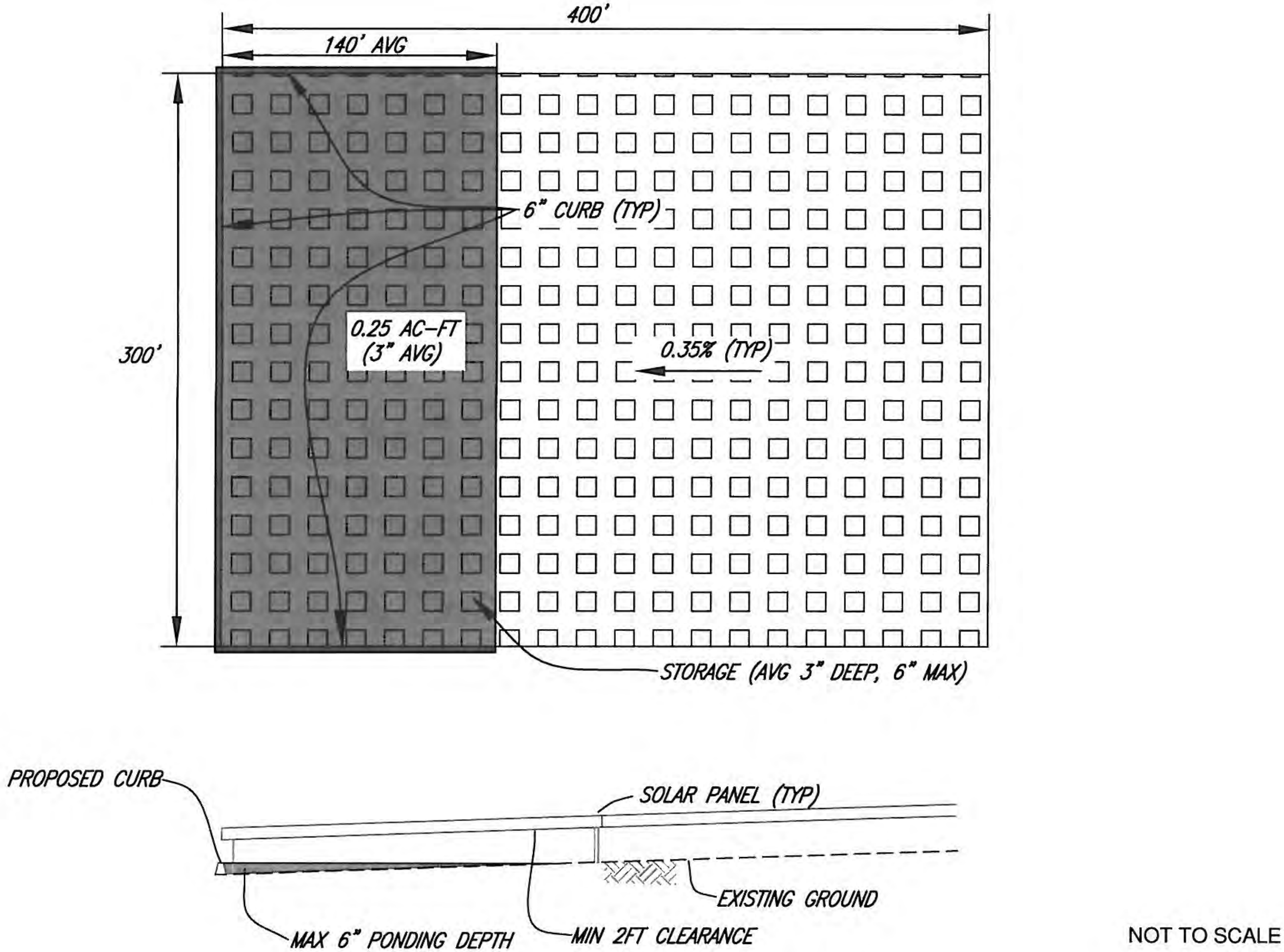


Figure 6: Imperial Valley South Solar Farm - Onsite Detention Concept

FIGURE 7 IMPERIAL VALLEY SOUTH SOLAR FARM – CONSTRAINTS MAP

PORTIONS OF SECTIONS 17, 20 & 21, T.17 S., R. 13 E., S.B.M.
ALL IN AN UNINCORPORATED AREA OF THE COUNTY OF IMPERIAL, STATE OF CALIFORNIA

SURVEYOR'S MONUMENTATION NOTES:

501. NORTHWEST CORNER SECTION 17, T17S, R13E – SEARCH FOUND NOTHING. SET MONUMENT AS INDICATED PER IMPERIAL COUNTY SURVEY TIES.

502. NORTH 1/4 CORNER SECTION 17, T17S, R13E – FOUND 2" IRON PIPE WITH CDH TAG, STAMPED IN PART "DEPT. OF TRANSPORTATION" FOR SAID CORNER, DOWN 0.3', PER IMPERIAL COUNTY SURVEY TIES.

503. RP TO NORTHEAST CORNER SECTION 17, T17S, R13E – FOUND 2" IRON PIPE, WITH BRASS DISK, DOWN 0.5', PER IMPERIAL COUNTY SURVEY TIES. ACCEPTED AS RP AS INDICATED.

504. EAST 1/4 CORNER SECTION 17, T17S, RR13E – FOUND 80–d SPIKE WITH PLASTIC TAG, STAMPED "SURVEY MARKER", PER IMPERIAL COUNTY SURVEY TIES. 80–d SPIKE REPORTED TO BE SET OVER IMPERIAL IRRIGATION DISTRICT CONCRETE CYLINDER, PER IMPERIAL COUNTY SURVEY TIES.

505. SOUTHWEST CORNER SECTION 17, T17S, R13E – FOUND 3" DIAMETER BRASS CAP, STAMPED IN PART "US DEPT OF INTERIOR – LAND MANAGEMENT – 1901", DOWN 3', PER IMPERIAL COUNTY SURVEY TIES.

506. RP TO NORTH 1/4 CORNER SECTION 20, T17S, R13E – FOUND 2–1/4" IRON PIPE, NO TAG, BENT OVER AND IN POOR CONDITION. ACCEPTED AS RP AS INDICATED ONLY.

507. INTENTIONALLY OMITTED.

508. INTENTIONALLY OMITTED.

509. EAST 1/4 CORNER SECTION 19, T17S, R13E – SEARCH FOUND NOTHING. IMPERIAL COUNTY SURVEY TIES GONE. SET MONUMENT AS INDICATED.

510. CC WEST LINE SECTION 19, T17S, R13E – FOUND 1–3/4" IRON PIPE WITH 2" BRASS CAP STAMPED IN PART "IMP CO SURV – 1992", 0.4 FT ABOVE GROUND, FOR SAID CLOSING CORNER PER IMPERIAL COUNTY SURVEY TIES. 1–3/4" IRON PIPE REPORTED TO BE SET OVER VERY OLD GLO IRON PIPE SET FOR CC PER IMPERIAL COUNTY SURVEY TIES.

511. RP TO WEST 1/4 CORNER SECTION 21, T17S, R13E – FOUND 1–3/4" IRON PIPE SET IN CONCRETE PER IMPERIAL COUNTY SURVEY TIES. ACCEPTED AS RP AS INDICATED.

512. WEST 1/4 CORNER SECTION 22, T17S, R13E –FOUND 2" IRON PIPE, WITH TAG "LS 5397", DOWN 1', PER IMPERIAL COUNTY SURVEY TIES. 2" IRON PIPE REPORTED TO BE SET OVER GLO IRON PIPE WITH BRASS CAP SET IN 1923, DOWN 3', PER IMPERIAL COUNTY SURVEY TIES.

513–516. INTENTIONALLY OMITTED

517. SOUTHWEST CORNER SECTION 16, T17S, R13E – FOUND 1–1/2" IRON PIPE, WITH TAG "LS 5397", PER RS 12–100. 1–1/2" IRON PIPE REPORTED TO BE SET OVER IMPERIAL IRRIGATION DISTRICT CONCRETE CYLINDER WHICH WAS SET OVER GLO IRON PIPE AND BOTTLE, PER RS 12–100.

518. SOUTH 1/4 SECTION 16, T17S, R13E – FOUND 1–1/2" IRON PIPE, WITH UNLEGIBLE TAG, ORIGIN UNKNOWN, FITS TIES. ACCEPTED AS MONUMENT SET TO PERPETUATE IMPERIAL COUNTY CONCRETE CYLINDER.

519. INTENTIONALLY OMITTED.

520. WEST 1/4 CORNER SECTION 21, T17S, R13E – SEARCH FOUND NOTHING. SET MONUMENT AS INDICATED PER IMEPERIAL COUNTY SURVEY TIES.

521–522. INTENTIONALLY OMIITED

523. CENTER CORNER SECTION 21, T17S, R13E – SEARCH FOUND NOTHING. SET MONUMENT AS INDICATED.

524. CENTER CORNER SECTION 20, T17S, R13E – SEARCH FOUND NOTHING. SET MONUMENT AS INDICATED.

525–549

550. INTERNATIONAL BOUNDARY MONUMENT "3M", SECTION 19, T17S, R13E – FOUND GLO BRASS CAP, STAMPED "US GENERAL LAND OFFICE SURVEY – 3M – CALIF/MEX 1928" SET FOR 3–MILE POST PER GLO PLAT.

551. CC WEST LINE SECTION 19, T17S, R13E – FOUND 2–1/4" IRON PIPE WITH 3–1/4" BRASS CAP STAMPED IN PART "US DEPT OF INTERIOR – 1991 – BLM", 1 FT ABOVE GROUND, FOR SAID CLOSING CORNER PER IMPERIAL COUNTY SURVEY TIES.

552. NORTHEAST CORNER SECTION 17, T17S, R13E –FOUND 2" IRON PIPE WITH CDH TAG, STAMPED IN PART "DEPT OF TRANSPORTATION 1999" FOR SAID CORNER, PER IMPERIAL COUNTY SURVEY TIES.

553. NORTH 1/4 CORNER SECTION 20, T17S, R13E –SEARCH FOUND NOTHING. SET MONUMENT AS INDICATED.

554. INTENTIONALLY OMITTED

555. SOUTHWEST CORNER SECTION 22, T17S, R13E – UNABLE TO SEARCH AS POSITION FALLS ON OPPOSITE SIDE OF BORDER FENCE. SET NOTHING.

556. INTENTIONALLY OMITTED.

557. INTERNATIONAL BOUNDARY MONUMENT NO. 223, SECTION 22, T17S, R13E – FOUND CONCRETE OBELISK STAMPED NO.223 SET FOR INTERNATIONAL BOUNDARY MONUMENT PER GLO PLAT.

558. INTERNATIONAL BOUNDARY MONUMENT "1M", SECTION 21, T17S, R13E – SEARCH FOUND NOTHING. POSITION ESTABLISHED BY GRANT BOUNDARY METHOD. SET NOTHING.

559–560. INTENTIONALLY OMITTED.

561. INTERNATIONAL BOUNDARY MONUMENT NO. 224, SECTION 24, T17S, R12E – FOUND CONCRETE OBELISK STAMPED NO.224 SET FOR INTERNATIONAL BOUNDARY MONUMENT PER GLO PLAT.

562–568. INTENTIONALLY OMITTED.

569. SOUTHEAST CORNER SECTION 20, T17S, R13E – UNABLE TO SEARCH AS POSITION FALLS ON OPPOSITE SIDE OF BORDER FENCE. SET NOTHING.

570–571. INTENTIONALLY OMITTED.

572. SOUTH 1/4 CORNER SECTION 21, T17S, R13E – UNABLE TO SEARCH AS POSITION FALLS ON OPPOSITE SIDE OF BORDER FENCE. SET NOTHING.

573–575. INTENTIONALLY OMITTED.

576. SOUTH 1/4 CORNER SECTION 20, T17S, R13E – SEARCH FOUND NOTHING. SET NOTHING.

577. SOUTHWEST SECTION 20, T17S, R13E – UNABLE TO SEARCH AS POSITION FALLS ON OPPOSITE SIDE OF BORDER FENCE. SET NOTHING.

578–580. INTENTIONALLY OMITTED.

581. INTERNATIONAL BOUNDARY MONUMENT "2M", SECTION 20, T17S, R13E – SEARCH FOUND NOTHING. POSITION ESTABLISHED BY GRANT BOUNDARY METHOD. SET NOTHING.

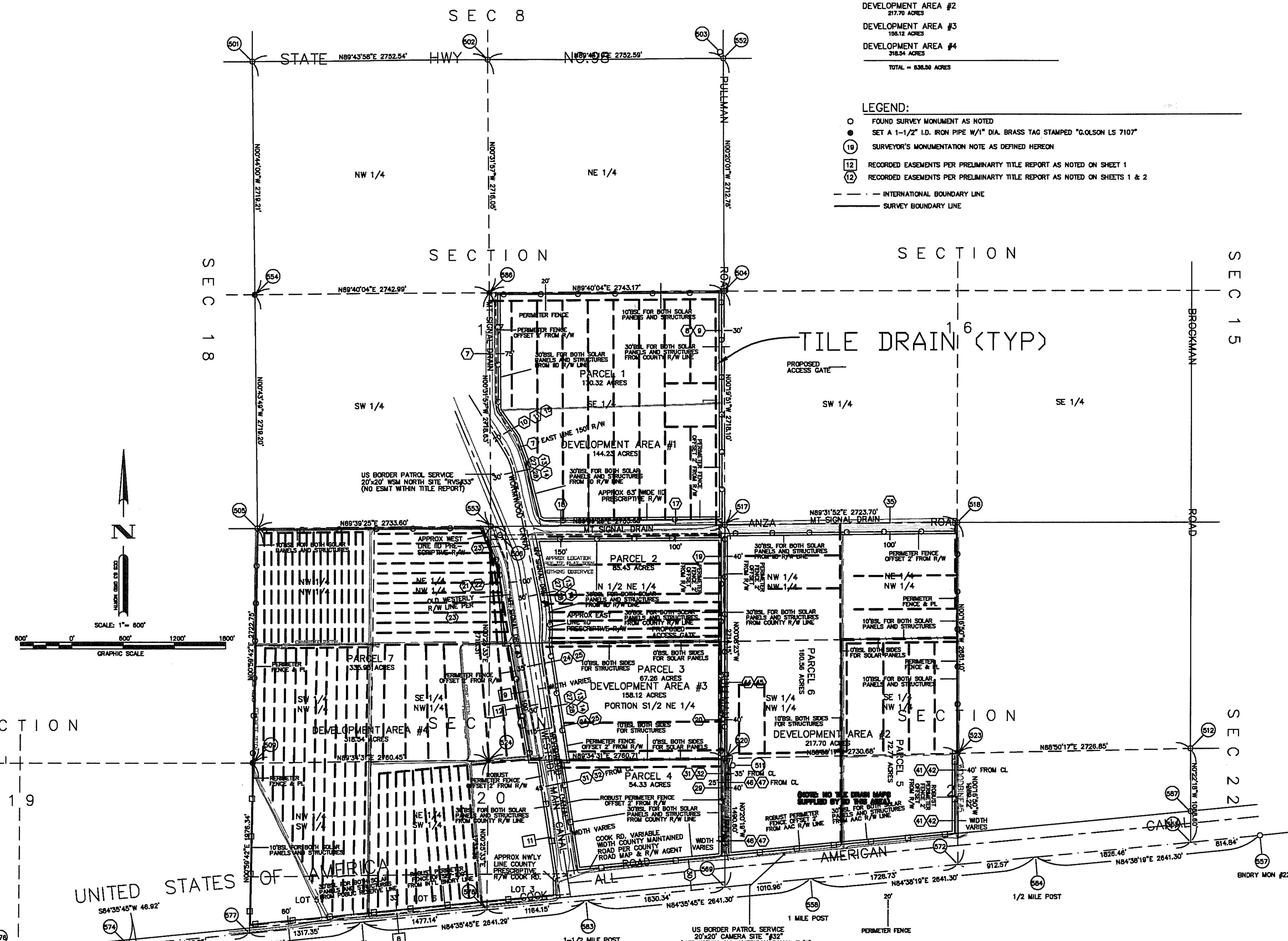
582. INTERNATIONAL BOUNDARY MONUMENT "2–1/2M", SECTION 19, T17S, R13E – SEARCH FOUND NOTHING. POSITION ESTABLISHED BY GRANT BOUNDARY METHOD. SET NOTHING.

583. INTERNATIONAL BOUNDARY MONUMENT "1–1/2M", SECTION 20, T17S, R13E – SEARCH FOUND NOTHING. POSITION ESTABLISHED BY GRANT BOUNDARY METHOD. SET NOTHING.

584. INTERNATIONAL BOUNDARY MONUMENT "1/2M", SECTION 21, T17S, R13E – SEARCH FOUND NOTHING. POSITION ESTABLISHED BY GRANT BOUNDARY METHOD. SET NOTHING.

585–588. INTENTIONALLY OMITTED.

589. SOUTH 1/4 CORNER SECTION 19, T17S, R13E – SEARCH FOUND NOTHING. SET NOTHING.



BENCH MARK	DEVELOPMENT DESIGN & ENGINEERING, INC	CONSTRAINTS MAP	SHEET
BRASS CAP STAMPED "DIXIE 1934: SET IN TOP OF SQUARE CONCRETE MONUMENT. LOCATED ON SOUTH SIDE OF EVAN HEWES HIGHWAY (FORMERLY HWY 80) APPROXIMATELY 6.3 MILES EAST OF JUNCTION OF EVAN HEWES HIGHWAY AND HASKELL ROAD.	PLANNING · CIVIL ENGINEERING · LAND SURVEYING · PROJECT MANAGEMENT 1065 STATE STREET EL CENTRO, CA 92243 760–353–8110 FAX (760–352–6408951) 695–7466	IV SOUTH SOLAR FARM	3 OF 3
ELEV = –4.39' (RAW) + 1000.00 = 995.61' (ADJUSTED)		COUNTY OF IMPERIAL, CALIFORNIA — DATE: 4–17–2010 — BY: G.O. CLIENT: LIGHTSOURCE RENEWABLES — FILE NAME: 10016IV SOUTH CON3.DWG — JOB NUMBER: 10016	

REFERENCE MATERIALS

- Precipitation Map
- Soils Map
- Site Soils Exhibit
- Imperial County General Requirements

Imperial Valley South Solar Farm Precipitation Data
(Location:32.663 N 115.660 W. Source: NOAA Atlas 14)

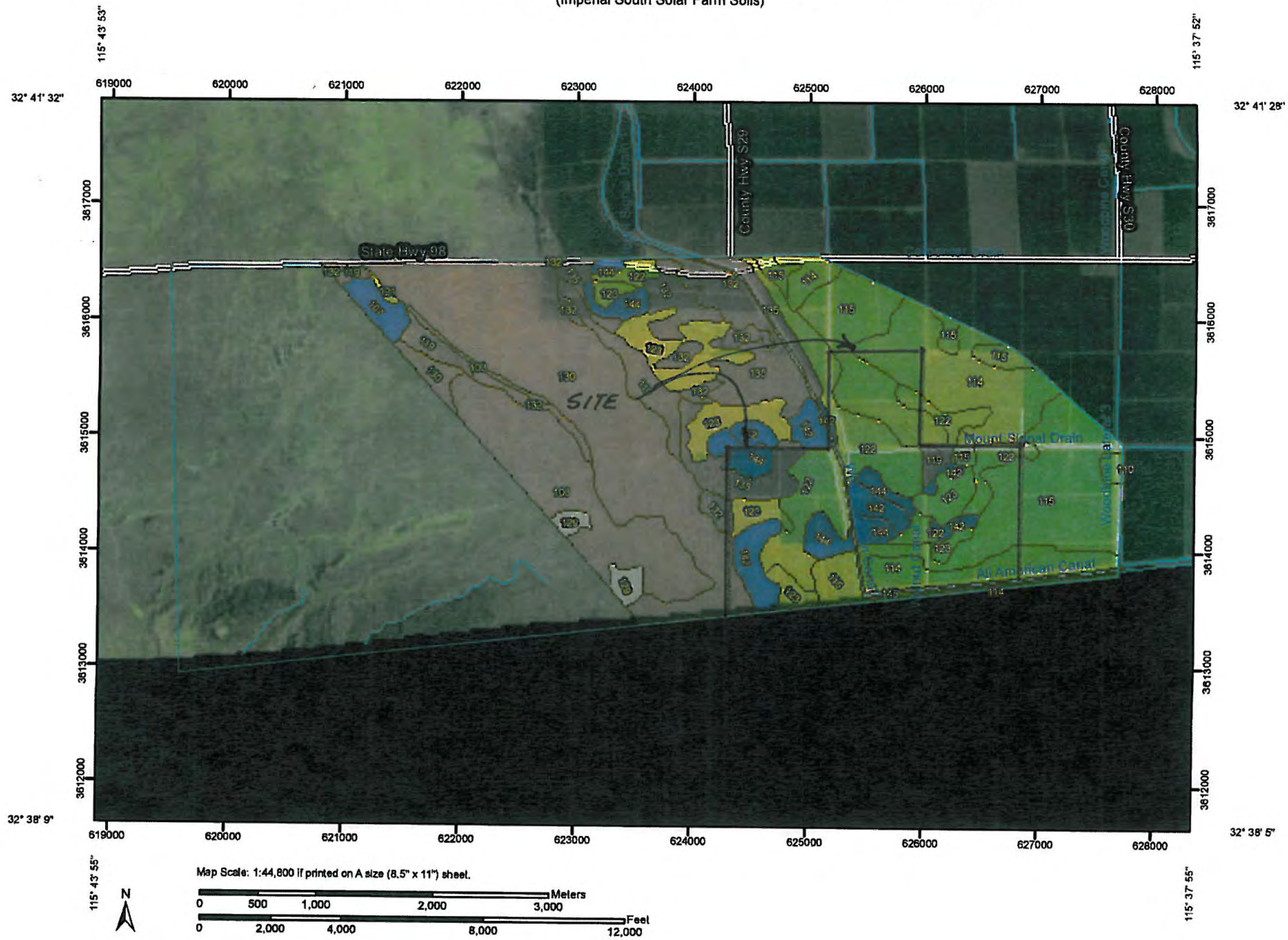
Precipitation Frequency Estimates (inches)																		
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	0.11	0.16	0.20	0.27	0.34	0.43	0.48	0.59	0.68	0.75	0.77	0.79	0.82	0.84	0.92	0.99	1.10	1.17
2	0.14	0.22	0.27	0.37	0.45	0.59	0.66	0.81	0.92	1.02	1.06	1.08	1.12	1.16	1.26	1.37	1.51	1.61
5	0.22	0.34	0.42	0.57	0.70	0.91	1.01	1.21	1.38	1.54	1.61	1.64	1.70	1.76	1.93	2.07	2.28	2.45
10	0.29	0.45	0.55	0.74	0.92	1.20	1.31	1.54	1.73	1.96	2.06	2.09	2.15	2.23	2.44	2.61	2.86	3.08
25	0.41	0.62	0.77	1.03	1.28	1.63	1.76	2.03	2.24	2.55	2.73	2.76	2.80	2.91	3.17	3.36	3.65	3.94
50	0.51	0.78	0.96	1.30	1.60	2.03	2.15	2.44	2.67	3.04	3.29	3.32	3.35	3.47	3.77	3.96	4.26	4.63
100	0.63	0.96	1.19	1.60	1.98	2.48	2.60	2.89	3.12	3.58	3.93	3.94	3.98	4.09	4.41	4.60	4.92	5.36
200	0.77	1.18	1.46	1.97	2.44	3.02	3.12	3.40	3.62	4.16	4.63	4.68	4.73	4.77	5.10	5.29	5.58	6.11
500	1.00	1.53	1.89	2.55	3.15	3.85	3.96	4.20	4.34	5.00	5.70	5.75	5.81	5.87	6.08	6.25	6.51	7.15
1000	1.21	1.84	2.29	3.08	3.81	4.60	4.72	4.96	5.08	5.71	6.60	6.67	6.73	6.80	6.91	7.04	7.23	7.97

Precipitation Depths

Precipitation Intensity Estimates (in/hr)																		
ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	1.28	0.98	0.81	0.54	0.34	0.21	0.16	0.10	0.06	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2	1.73	1.31	1.09	0.73	0.45	0.29	0.22	0.13	0.08	0.04	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00
5	2.69	2.04	1.69	1.14	0.70	0.46	0.34	0.20	0.11	0.06	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00
10	3.52	2.68	2.21	1.49	0.92	0.60	0.43	0.26	0.14	0.08	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.00
25	4.88	3.72	3.07	2.07	1.28	0.82	0.58	0.34	0.19	0.11	0.06	0.03	0.02	0.01	0.01	0.00	0.00	0.00
50	6.12	4.66	3.85	2.59	1.60	1.02	0.72	0.41	0.22	0.13	0.07	0.03	0.02	0.01	0.01	0.01	0.00	0.00
100	7.57	5.76	4.76	3.21	1.98	1.24	0.87	0.48	0.26	0.15	0.08	0.04	0.02	0.02	0.01	0.01	0.00	0.00
200	9.29	7.07	5.84	3.93	2.44	1.51	1.04	0.57	0.30	0.17	0.10	0.05	0.03	0.02	0.01	0.01	0.01	0.00
500	12.04	9.16	7.57	5.10	3.15	1.93	1.32	0.70	0.36	0.21	0.12	0.06	0.03	0.02	0.01	0.01	0.01	0.00
1000	14.56	11.07	9.15	6.16	3.81	2.30	1.57	0.83	0.42	0.24	0.14	0.07	0.04	0.03	0.01	0.01	0.01	0.01

Precipitation Intensity

Hydrologic Soil Group—ANZA-BORREGO AREA, CALIFORNIA; and Imperial County, California, Imperial Valley Area
(Imperial South Solar Farm Soils)



USDA Natural Resources Conservation Service

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Soil Ratings
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads

MAP INFORMATION

Map Scale: 1:44,800 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 11N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: ANZA-BORREGO AREA, CALIFORNIA
Survey Area Data: Not available

Soil Survey Area: Imperial County, California, Imperial Valley Area
Survey Area Data: Version 5, Jul 25, 2008

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Date(s) aerial images were photographed: 6/12/2005; 5/30/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Imperial County, California, Imperial Valley Area				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
103	CARSITAS GRAVELLY SAND, 0 TO 5 PERCENT SLOPES	A	339.0	5.7%
107	GLENBAR COMPLEX	B	37.6	0.6%
110	HOLTVILLE SILTY CLAY, WET	C	12.8	0.2%
114	IMPERIAL SILTY CLAY, WET	C	415.0	7.0%
115	IMPERIAL-GLENBAR SILTY CLAY LOAMS, WET, 0 TO 2 PERCENT SLOPES	C	630.5	10.6%
119	INDIO-VINT COMPLEX	A	123.0	2.1%
121	MELOLAND FINE SAND	C	4.8	0.1%
122	MELOLAND VERY FINE SANDY LOAM, WET	C	357.0	6.0%
123	MELOLAND AND HOLTVILLE LOAMS, WET	C	257.0	4.3%
129	PITS		32.9	0.6%
130	ROSITAS SAND, 0 TO 2 PERCENT SLOPES	A	721.2	12.2%
132	ROSITAS FINE SAND, 0 TO 2 PERCENT SLOPES	A	148.8	2.5%
135	ROSITAS FINE SAND, WET, 0 TO 2 PERCENT SLOPES	A	290.8	4.9%
142	VINT LOAMY VERY FINE SAND, WET	B	148.0	2.5%
144	VINT AND INDIO VERY FINE SANDY LOAMS, WET	B	134.6	2.3%
145	WATER		32.7	0.6%
Subtotals for Soil Survey Area			**3,685.9**	**62.1%**
Totals for Area of Interest			**5,931.3**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

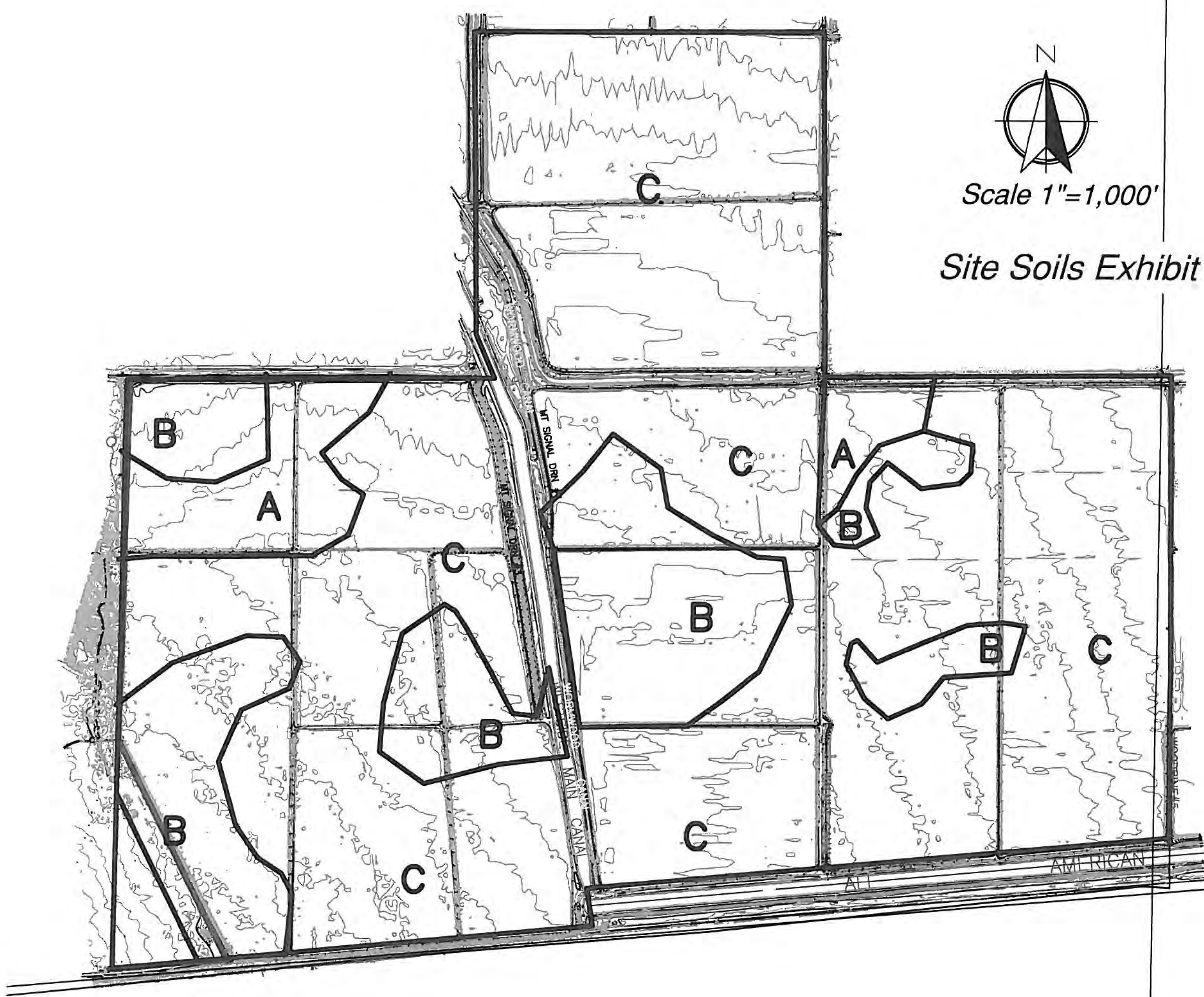
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower



N
Scale 1"=1,000'
Site Soils Exhibit
A
B
C
MT SIGNAL DRN
WORMWOOD CANAL
MAIN CANAL
ALL AMERICAN

III A. **GENERAL REQUIREMENTS**

1. All drainage design and requirements are recommended to be in accordance with the Imperial Irrigation District (IID) "Draft" Hydrology Manual or other recognized source with approval by the County Engineer and based on full development of upstream tributary basins. Another source is the Caltrans I-D-F curves for the Imperial Valley.

2. Public drainage facilities shall be designed to carry the ten-year six-hour storm underground, the 25-year storm between the top of curbs provided two 12' minimum width dry lanes exist and the 100-year frequency storm between the right of way lines with at least one 12' minimum dry lane open to traffic. All culverts shall be designed to accommodate the flow from a 100-year frequency storm.

3. Permanent drainage facilities and right of way, including access, shall be provided from development to point of satisfactory disposal.

4. Retention volume on retention or detention basins should have a total volume capacity for a three (3) inch minimum precipitation covering the entire site with no C reduction factors. Volume can be considered by a combination of basin size and volume considered within parking and/or landscaping areas.

   There is no guarantee that a detention basin outletting to an IID facility or other storm drain system will not back up should the facility be full and unable to accept the project runoff. This provides the safety factor from flooding by ensuring each development can handle a minimum 3-inch precipitation over the project site.

5. Retention basins should empty within 72 hours and no sooner than 24 hours in order to provide mosquito abatement. Draining, evaporation or infiltration, or any combination thereof can accomplish this. If this is not possible then the owner should be made aware of a potential need to address mosquito abatement to the satisfaction of the Environmental Health Services (EHS) Department. Additionally, if it is not possible to empty the basin within 72 hours, the basin should be designed for 5 inches, not 3 inches as mentioned in Item #4 above. This would allow for a saturation condition of the soil due to a 5" storm track. EHS must review and approve all retention basin designs prior to County Public Works approval. Nuisance water must not be allowed to accumulate in retention basins. EHS may require a nuisance water abatement plan if this occurs.

6. The minimum finish floor elevation shall be 12" above top of fronting street curb unless property is below street level and/or 6" above the 100-year frequency storm event or storm track. A local engineering practice is to use a 5" precipitation event as a storm track in the absence of detailed flood information.

   The 100-year frequency storm would be required for detention calculations.

7. Finish pad elevations should be indicated on the plans, which are at or above the 100-year frequency flood elevation identified by the engineer for the parcel. Finish floor elevations should be set at least 6 inches above the 100-year flood elevation.

8. The developer shall submit a drainage study and specifications for improvements of all drainage easements, culverts, drainage structures, and drainage channels to the Department of Public Works for approval. Unless specifically waived herein, required plans and specifications shall provide a drainage system capable of handling and disposing of all surface waters originating within the subdivision and all surface waters that may flow onto the subdivision from adjacent lands. Said drainage system shall include any easements and

structures required by the Department of Public Works or the affected Utility Agency to properly handle the drainage on-site and off-site. The report should detail any vegetation and trash/debris removal as well as address any standing water.

9. Hydrology and hydraulic calculations for determining the storm system design shall be provided to the satisfaction of the Director, Department of Public Works. When appropriate, water surface profiles and adequate field survey cross-section data may also be required.

10. An airtight or screened oil/water separator or equivalent is required prior to permitting onsite lot drainage from entering any street right of way or public storm drain system for all industrial/commercial or multi residential uses. A maximum 6" drain lateral can be used to tie into existing adjacent street curb inlets with some exceptions. Approval from the Director of Public Works is required.

11. The County is implementing a storm water quality program as required by the State Water Resources Control Board, which may modify or add to the requirements and guidelines presented elsewhere in this document.

    This can include ongoing monitoring of water quality of storm drain runoff, implementation of Best Management Practices (BMPs) to reduce storm water quality impacts downstream or along adjacent properties. Attention is directed to the need to reduce any potential of vectors, mosquitos or standing water.

12. A Drainage Report is required for all developments in the County. It shall include a project description, project setting including discussions of existing and proposed conditions, any drainage issues related to the site, summary of the findings or conclusions, offsite hydrology, onsite hydrology, hydraulic calculations and a hydrology map.

13. Specific to small Parcel Map developments:

A. For individual lots, sufficient storage volume must be available on a portion of the proposed parcel to accommodate a three (3) inch precipitation minimum covering the entire area. The resulting storage volume should be accommodated in a single retention basin. However, this office will consider a combination of retention basins and on-lot storage.

B. Remaining portions of the parcel or agricultural parcels that are not being developed should also provide for onsite retention or assurances that the resulting storm runoff does not impact adjacent parcels.

C. Finish pad elevations should be indicated on the plans, which are at or above the 100-year frequency flood elevation identified by the engineer for the parcel. Finish floor elevations should be set at least 6 inches above the 100-year flood elevation.

D. Onsite driveways should be designed and constructed such that they are at least 3 inches above the 100-year frequency flood elevation identified for the parcel.

E. Septic system manhole access, water systems and other associated electrical appurtenances should also have finish elevations indicated on the plans that are at least 6" above the 100 year frequency flood elevation identified for the parcel.

F. Retention basins should empty within 72 hours in order to provide mosquito abatement. This can be accomplished by either draining, evaporation or infiltration, or any combination thereof. If this is not possible, then the owner should be made aware of a potential need to address mosquito abatement to the satisfaction of the Environmental Health Services Department. Additionally, if it is not possible to empty the basin within 72 hours, the basin should be designed for 5 inches, not 3 inches as mentioned in Item #A above. This would allow for a saturation condition of the soil due to a 5" storm track.

Detention Basin Design and Maintenance Guideline Note:

The Imperial County Division of Environmental Health Services Vector Control Program is responsible for vector and mosquito control through a variety of means. Poorly designed and ill-maintained detention basins are capable of breeding large numbers of vectors or mosquitoes and offer excellent harborage for adult mosquitoes from other sources. Because detention basins are often situated in residential neighborhoods and other populated areas, they present a significant health risk and pose a challenging pesticide application situation. The California Health and Safety Codes provide for public nuisance abatement and prevention. EHS has guidelines available and they will review all storm retention basin systems prior to Public Works approval.

III B. **HYDROLOGY**

1. Off-site, use a blue line or Xerox prints of the subdivision or tract map. Show existing culverts, cross-gutters and drainage courses based on field review. Indicate the direction of flow; clearly delineate each drainage basin showing the area and discharge and the point of concentration.

2. On-site, use the grading plan. If grading is not proposed, then use a 100-scale plan or greater enlargement. Show all proposed and existing drainage facilities and drainage courses. Indicate the direction of flow. Clearly delineate each drainage basin showing the area and discharge and the point of concentration.

3. Use the rational formula Q (flow (cfs)=C I A (area/acreage) for watersheds less than 0.5 square mile unless an alternate method is approved by the County Engineer. For watersheds in excess of 0.5 square mile, the method of analysis shall be approved by the County Engineer prior to submitting calculations.

III C. **HYDRAULICS**

All facilities that convey drainage must have calculations to support its use. These facilities include streets, culverts, storm drains, channels, catch basins, inlets, etc.

1. Street – provide:

    a) Depth of gutter flow calculation.

    b) Inlet calculations.

    c) Show gutter flow Q, inlet Q, and bypass Q on a plan of the street.

2. Storm drain pipes and open channels – provide:

    a) Hydraulic loss calculations for: entrance, friction, access holes, junctions, bends, angles, reduction and enlargement.

    b) Analyze existing conditions upstream and downstream from proposed system, to be determined by the County Engineer on a case-by-case basis.

c) Calculate critical depth and normal depth for open channel flow conditions.

d) Design for non-silting velocity of 4 feet per second in a two-year frequency storm unless otherwise approved by the County Engineer.

e) All pipes and outlets shall show HGL (hydraulic grade line); velocity and Q value(s) for which the storm drain is designed to discharge.

f) Confluence angles shall be maintained between 45° and 90° from the main upstream flow. Flows shall not oppose main line flows.

III D. **INLETS**

1. Curb inlets at a sump condition should be designed for two CFS (cubic feet per second) per lineal foot of opening when headwater may rise to the top of curb.

2. Curb inlets on a continuous grade should be designed based on the following equation:

$$Q=0.7\ L\ (a+y) * 3/2$$

Where:
y = depth of flow in approach gutter in feet
a = depth of depression of flow line at inlet in feet
L = length of clear opening in feet (maximum 30 feet)
Q = flow in CFS

3. Grated inlets should be avoided when possible. When necessary, the design should be based on the Bureau of Public Roads Nomographs (now known as the Federal Highway Administration). All grated inlets shall be bicycle proof.

4. All catch basins shall have an access main, a minimum of 24 inches in diameter in the top unless access through the grate section is satisfactory to the County Engineer.

5. Catch basins/curb inlets shall be located so as to eliminate, whenever possible, cross gutters. Catch basins/curb inlets shall not be located within 5 feet of any curb return or driveway.

6. Minimum connector pipes for pubic drainage systems shall be 18 inches.

7. Flow through inlets may be used when pipe size is 24 inches or less and open channel flow characteristics exist.

III E. **STORM DRAINS**

1. Minimum pipe slopes shall be 0.001 (0.1%) unless otherwise approved by the County Engineer.

2. Minimum storm drain, within public right of way, size shall be 18-inch diameter.

3. Provide cleanouts at 300 feet maximum spacing and at angle points and at breaks in grade greater than 10°. For pipes 48 inches in diameter and larger, a maximum spacing of 500 feet may be used.

4. The material for storm drains in right-of-way shall be rubber gasket reinforced concrete pipe, poly vinyl chloride pipe or HDPE storm drainpipe designed in conformance with Imperial County design criteria.

5. Horizontal and vertical curve design shall conform to manufacturer recommended specifications.

6. The pipe invert elevations, slope, and pipe profile line shall be delineated on the Mylar of the improvement plans.

   The strength classification of any pipe shall be shown on the plans. Minimum strength for RCP shall be Class III in all County streets or future right of way. Minimum strength for depths less than 2 feet, if allowed, shall be Class V or greater.

   PVC pipe, if used, must meet or exceed standards for schedule 40-wall thickness and SDR values. Thirty (30) inches minimum cover depth is required. (See Section II J.)

7. For all drainage designs that are not covered in these standards, other established standard practice criteria can be used as approved by the Director of Public Works.

8. For storm drain discharging into unprotected or natural channel, proper energy dissipation measures shall be installed to prevent damage or erosion.

9. The use of detention basins to even out storm peaks and reduce piping is permitted with substantiating engineering calculations and proper maintenance agreements.

10. Desiltation measures for silt caused by development shall be provided and cleaned regularly and after major rainfall events as required by the County Engineer or his designated representative. Adequate storage capacity shall be maintained at all times.

11. Protection of downstream or adjacent properties from incremental flows (caused by change from an underdeveloped to a developed site) shall be provided. Such flows shall not be concentrated and directed across unprotected adjacent properties unless an easement and storm drains or channels to contain flows are provided.

12. Storm drainpipe under pressure flow for the design storm, i.e., HGL above the soffit of the pipe, shall meet the requirements of ASTM C76, C361, and C443 for water-light joints in the section of pipe calculated to be under pressure.

III F. <u>DRAINAGE SPECIFICATIONS AND DESIGN STANDARDS</u>

"To be Added"

Imperial Solar Energy Center South

Appendix H2

Preliminary Water Quality Report

Prepared by Tory R. Walker Engineering, Inc.

October 4, 2010

PRELIMINARY WATER QUALITY REPORT

For

Imperial Valley South Solar Farm

Prepared For:
LightSource Renewables, LLC
9151 Rehco Road
San Diego, CA 92121
(949) 270-6348

Prepared By:
Tory R. Walker Engineering, Inc.
973 Vale Terrace, Suite 202
Vista, CA 92084
(760)414-9212

4 October 2010

Tory R. Walker, R.C.E. 45005
President

TABLE OF CONTENTS

ATTACHMENTS

LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

The purpose of this Water Quality Report is to address water quality impacts from the proposed Imperial Valley South Solar Farm project. Site design, source control, and treatment control Best Management Practices (BMPs) will be utilized to provide long term solutions to protect storm water quality. This report is subject to revisions as needed to accommodate changes to the project design, or as required by the County and/or Engineer.

1.1 Project Location

The project site is located in Imperial County between Mt. Signal Road and Pulliam Road and south of Highway 98. Figure 1.1 (below) illustrates the project location.

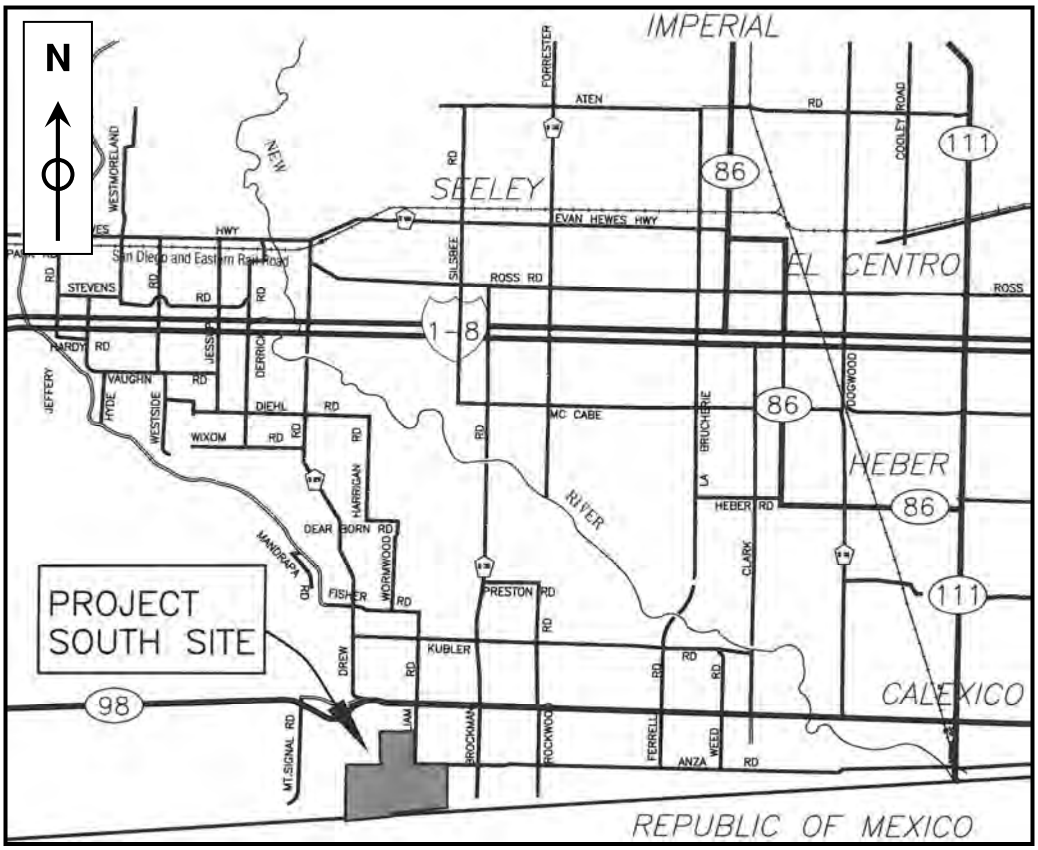


Figure 1.1 Vicinity Map (No Scale)

1.2 Project Description

This project will construct a photovoltaic Solar Energy Farm and will utilize the area bordered by Mt. Signal road to the west, Pulliam Road to the east, the US/Mexico Border to the south, and just south of Highway 98 to the North. Existing runoff flows generally south to north and the majority of the existing drainage pattern will be unchanged. Details can be found in the drainage report titled "Preliminary CEQA Level Drainage Study for Imperial Valley South Solar Farm" dated 4 October 2010 prepared by Tory R. Walker Engineering, Inc.

1.3 Project Size

The project area is approximately 838 acres.

1.4 Impervious and Pervious Surface areas

The existing project area is currently crop fields, approximately 0% impervious, and will increase just over ½ percent to 0.6% impervious with the proposed construction. The project includes approximately 118 concrete slab pads for the inverter units, a 5,000 ft^2 operations and maintenance building with associated parking lot of approximately 6,850 ft^2, a 5,000 ft^2 water treatment building, and solar panels supported on posts (making a negligible impervious footprint). The project will utilize a gravel surface for the service roads.

2.0 PROJECT SITE ASSESSMENT

This section includes information used to consider the potential water quality and hydrologic impacts from the proposed project. This information is important when considering the appropriate BMPs to reduce identified potential impacts as well as designing source control and treatment control measures to reduce those impacts.

2.1 Land Use and Zoning

Historic Land Use is cropland.

2.2 Existing Topography

The project site area is generally flat, sloping gently from south to north, with elevations ranging from 12 feet above sea level to 9 feet below sea level.

2.3 Existing and Proposed Drainage

In the existing condition, runoff generally flows from south to north. Proposed condition drainage patterns will be similar, with runoff flowing from south to north. Runoff from significant areas of the site in the proposed condition will sheet flow across the site as in the existing condition and be collected by ditches and culverts and routed to the Imperial Irrigation District (IID) drain system. There is an existing onsite system comprised of perforated tile drains that may convey flows to the IID drain system. These drains include the Mt. Signal Drain #3 and 4, the Carpenter Drain #1, and the Greeson Drain. Detention will be provided on the site so that the proposed drainage replicates the existing condition. Details can be found in the drainage report titled "Preliminary CEQA Level Drainage Study for Imperial Valley South Solar Farm" dated 4 October 2010 prepared by Tory R. Walker Engineering, Inc.

2.4 Watershed, Receiving Waters, and Beneficial Uses

The proposed project is located within the Imperial Hydrologic Unit, Brawley Hydrologic Area, and an undefined Hydrologic Sub-area (Basin Number 723.10). The surface and groundwater receiving waters located in the area and downstream of this project include the Mt. Signal Drain #3 and 4, the Carpenter Drain #1, the Greeson Drain, the New River, and the Salton Sea.

From Table 2-3 of the Water Quality Control Plan for the Colorado River Basin Region the Beneficial Uses of the area west of the Mt. Signal Drain #3 and 4 and the Carpenter Drain #1 (all considered part of the IID drains), the Greeson Drain, the New River, and the Salton Sea are as follows:

Table 1

Ground Waters	Hydrologic Unit Basin Number	MUN	AGR	IND	PROC	GWR	FRESH	POW	REC1	REC2	BIOL	WARM	COLD	WILD	RARE	SPWN	AQUA
Imperial Valley Drains	723.10						X		X	X		X		X	X		
New River	723.10			X			X		X	X		X		X	X		
Salton Sea	728.00			X					X	X		X		X	X		X

2.5 303(d) Listed Receiving Waters

The impaired waterbodies listed on the 303(d) list for this Hydrologic Area (728) are the Imperial Valley Drains, the New River and the Salton Sea. This project does not flow to a drain included on the 303(d) listing of Imperial Valley Drains so no drain listings are provided in this section. The New River is listed for 1,2,4-Trimethylbenzene, Chlordane, Chloroform, Chlorpyrifos, Copper, DDT, Diazinon, Dieldrin, Mercury, meta-par xlyenes, Nutrients, Organic Enrichment/Low Dissolved Oxygen, o-Xylenes, PCBs, p-Cymene, p-Dichlorobenzene/DCB, Pesticides, Selenium, Toluene, Toxaphene, Toxicity, and Trash. The Salton Sea is listed for Nutrients, Salinity, and Selenium.

The project is approximately: less than 100 yards to the Mt. Signal Drain #3 and 4, less than 100 yards to the Carpenter Drain #1, 3 miles to the Greeson Drain, 7 miles to the New River, and 52 miles to the Salton Sea.

2.6 Total Maximum Daily Loads (TMDLs)

Table 2

Receiving Water	Hydrologic Unit Basin Number	TMDL	Distance From Project (miles)
Imperial Valley Drain (Mt. Signal Drain #3 and 4, the Carpenter Drain #1, and the Greeson Drain)	723.10	Sedimentation./Siltation	~100 yards
New River	723.10	Pathogens Sedimentation./Siltation Trash	~ 7

2.7 Soil Type(s) and Conditions

Soil types are classified as hydrologic soil groups A through C. Existing vegetation is agricultural cropland.

3.0 POLLUTANTS OF CONCERN

This section identifies pollutants of concern.

3.1 Project Categories and Features

The project includes concrete slab pads for the inverter units, an operations and maintenance building with associated parking lot and a water treatment building, and solar panels supported on posts (making a negligible impervious footprint). The project will utilize pervious gravel surfaces for the service roads. Project will include a septic system for sanitary sewage disposal.

3.2 Pollutants of Concern

Downstream waters are listed for the following pollutants of concern which are also potential pollutants from this project:

3.2 (a) – Sediments

Soils or other surface materials eroded and then transported or deposited by the action of wind, water, ice, or gravity. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, smother bottom dwelling organisms, and suppress aquatic vegetative growth.

3. 2 (b) – Heavy Metals

Metals are raw material components in non-metal products such as fuels, adhesives, paints, and other coatings. Primary sources of metal pollution in storm water are typically commercially available metals and metal products. Metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and cooling tower systems. Metals occur naturally at low concentrations in soil, and are not toxic at these concentrations. However, at higher concentrations, certain metals can be toxic to aquatic life. Humans can be impacted from contaminated groundwater resources and bioaccumulation of metals in fish and shellfish. Environmental concerns, regarding the potential for release of metals to the environment, have already led to restricted metal usage in certain applications.

3. 2 (c) – Trash & Debris

Examples include paper, plastic, leaves, grass cuttings, and food waste, which may have a significant impact on the recreational value of a water body and aquatic habitat. Excess organic matter can create a high biochemical oxygen demand in a stream and thereby lower its water quality. In areas where stagnant water is present, the presence of excess organic matter can promote septic conditions resulting in the growth of undesirable organisms and the release of odorous and hazardous compounds such as hydrogen sulfide.

3. 2 (d)– Oil & Grease

Characterized as high high-molecular weight organic compounds. Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, oils, waxes, and high-molecular weight fatty acids. Elevated oil and grease content can decrease the aesthetic value of the water body, as well as the water quality.

3. 2 (e)– Pesticides

Chemical compounds commonly used to control nuisance growth or prevalence of organisms and includes herbicides. Excessive application of a pesticide may result in runoff containing toxic levels of its active component.

3.3 Project Water Quality Analyses

Tributary flows from over 838 acres will be attenuated onsite, replicating the pre-project condition. Runoff will be detained in under-panel and designated detention basins.

4.0 BEST MANAGEMENT PRACTICES (BMPs)

Site Design, Source Control, and Treatment Control BMPs will be utilized and are described in the following sections.

4.1 Site Design Strategies and BMPs

Conceptually, there are three strategies for managing runoff from buildings and paving:

1. Optimize the site layout;
2. Use pervious surfaces;
3. Disperse runoff.

This section describes how Site Design strategies have been implemented in the proposed project design.

4.1.1 Optimize the Site Layout

The very nature of the proposed land use optimizes the site layout thus limiting the development envelope. The existing drainage patterns will be maintained.

4.1.2 Use Pervious Surfaces

Service roads will use a pervious gravel surface.

4.1.3 Disperse Runoff

The pervious surfaces will drain to detention areas within the project site.

4.2 Source Control BMPs

It is possible that the following pollutants could be generated at this site: Sediment, Heavy Metals, Trash & Debris, Oil & Grease, and Pesticides.

Based on these anticipated pollutants and operational activities at the site the Source Control BMPs to be installed and/or implemented onsite are summarized below:

- Trash storage
- Integrated Pest Management
- Efficient irrigation and landscape design
- Property owner educational materials regarding source control management

4.3 Treatment Control BMPs

Structural Treatment (treatment control) BMPs are engineered, designed, and constructed to remove pollutants from urban runoff by simple gravity settling of particulate pollutants, filtration, biological uptake, media absorption, or any other physical, biological, or chemical process.

This section discusses the basis for selection and details of the proposed structural treatment BMPs being utilized on this project, as well as methodology used to determine the peak rate of runoff to be treated. Also discussed are targeted pollutants and pollutant removal efficiency information.

The Preliminary CEQA Level Drainage Study for Imperial Valley West Solar Farm" dated 4 October 2010 prepared by Tory R. Walker Engineering, Inc. is the basis for design of the structural treatment BMPs. The SCS Method was used to determine the flows for the existing and proposed conditions. Rainfall data was determined from the NOAA 14 Atlas.

The structural treatment BMPs and drainage facilities can be seen on Figure 2, Site Map (BMP Location Map) located in Attachment 2. Extended Detention Basins were sized for the major subareas and the Operations and Maintenance Facility. Under-panel detention will also be utilized on the eastern portion of the site.

Typical pollutant removal efficiencies of treatment control BMPs are shown in Table 3 below. The column entitled, "Detention Basins" is shaded to reflect the treatment BMP proposed for the site.

Table 3

Pollutant of Concern	***Treatment Control BMP Categories***						
	Biofilters	Detention Basins	Infiltration Basins(2)	Wet Ponds or Wetlands	Drainage Inserts	Filtration(4)	Hydrodynamic Separator Systems(3)
Sediment	M	H	H	H	L	H	M-H
Nutrients	L	M	M	M	L	M-H	L-M
Heavy Metals	M	M	M	H	L	H	L-M
Organic Compounds	U	U	U	U	L	M-H	L-M
Trash & Debris	L	H	U	U	M	H	M-H
Oxygen Demanding Substances	L	M	M	M	L	M-H	L
Bacteria	U	U	H	U	L	M	L
Oil & Grease	M	M	U	U	L	H	L-H
Pesticides	U	U	U	U	L	L-H	L

(1) Copermittees are encouraged to periodically assess the performance characteristics of many of these BMPs to update this table.
(2) Including trenches and porous pavement.
(3) Also known as hydrodynamic devices.
(4) For Proprietary Structural BMPs, not all serve the same function or have the same efficiency.

L (Low): Low removal efficiency (roughly 0-25%)
M (Medium): Medium removal efficiency (roughly 25-75%)
H (High): High removal efficiency (roughly 75-100%)
U: Unknown removal efficiency, applicant must provide evidence supporting use

Sources: *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (1993), *National Stormwater Best Management Practices Database* (2001), and *Guide for BMP Selection in Urban Developed Areas* (2001).

4.3.1 Detention Basins

Detention basins are passive systems whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time to allow particles and associated pollutants to settle. They can also be used to provide flood control by including additional flood detention storage. They have high removal effectiveness for trash and medium effectiveness for Sediment, nutrients, metals, bacteria, oil and grease, and organics. This project is anticipated to generate sediment similar to the pre-developed condition. It has the potential to generate trash.

5.0 PROJECT PLAN(s) & BMP LOCATION MAP

BMP Location Map is provided in Attachment 2.

6.0 BMP MAINTENANCE

Proper maintenance is required to insure optimum performance of the Detention Basins. Maintenance will be the responsibility of the owner throughout the life of the project. Owner will also instruct any future owner of the maintenance responsibility. The operational and maintenance needs of the proposed detention basins and under-panel detention basins include:

- Periodic sediment removal.
- Monitoring of the basin to ensure it is completely and properly drained.
- Outlet structure cleaning.
- Vegetation management.
- Removal of weeds, tree pruning, leaves, litter, and debris.
- Vegetative stabilization of eroding banks.

Inspection Frequency

The facility will be inspected and inspection visits will be completely documented:

- Once during the rainy season and once between each rainy season at a minimum.
- After every large storm (after every storm monitored or those storms with more than 0.50 inch of precipitation).

Aesthetic and Functional Maintenance

Functional maintenance is important for performance and safety reasons. Aesthetic maintenance is important for public acceptance of storm water facilities.

Aesthetic Maintenance

The following activities will be included in the aesthetic maintenance program:

- <u>Weed Control</u>. Weeds will be removed through mechanical means.

Functional Maintenance

Functional maintenance has two components:

- Preventive maintenance.
- Corrective maintenance.

Preventive Maintenance

Preventive maintenance will be done on a regular basis. Preventive maintenance activities to be instituted at a basin are:

- Trash and Debris. During each inspection and maintenance visit to the site, debris and trash removal will be conducted to reduce the potential for inlet and outlet structures and other components from becoming clogged and inoperable during storm events.
- Sediment Management. Alluvial deposits at the inlet structures may create zones of ponded water. Upon these occurrences these deposits will be graded within the basin in an effort to maintain the functionality of the BMP. Sediment grading will be accomplished by manually raking the deposits.
- Sediment Removal. Surface sediments will be removed when sediment accumulation is greater than 18-inches, or 10 percent of the basin volume, whichever is less. Vegetation removed with any surface sediment excavation activities will be replaced through reseeding.
- Mechanical Components. Regularly scheduled maintenance will be performed on valves, fence gates, locks, and access hatches in accordance with the manufacturers' recommendations. Mechanical components will be operated during each maintenance inspection to assure continued performance.
- Elimination of Mosquito Breeding Habitats. The most effective mosquito control program is one that eliminates potential breeding habitats.

Corrective Maintenance

Corrective maintenance is required on an emergency or non-routine basis to correct problems and to restore the intended operation and safe function of a basin. Corrective maintenance activities include:

- Removal of Debris and Sediment. Sediment, debris, and trash, which threaten the ability of a basin to store or convey water, will be removed immediately and properly disposed of.
- Structural Repairs. Repairs to any structural component of a basin will be made promptly (e.g., within 10 working days). Designers and contractors will conduct repairs where structural damage has occurred.
- Embankment and Slope Repairs. Damage to the embankments and slopes will be repaired quickly (e.g., within 10 working days).
- Erosion Repair. Where a reseeding program has been ineffective, or where other factors have created erosive conditions (i.e., pedestrian traffic, concentrated flow, etc.), corrective steps will be taken to prevent loss of soil and any subsequent danger to the performance of a basin. There are a number of corrective actions than can be taken. These include erosion control blankets, riprap, sodding, or reduced flow through the area. Design engineers will be consulted to address erosion problems if the solution is not evident.
- Fence Repair. Timely repair of fences (e.g., within 10 working days) will be done to maintain the security of the site.
- Elimination of Trees and Woody Vegetation. Woody vegetation will be removed from embankments.
- Elimination of Animal Burrows. Animal burrows will be filled and steps taken to remove the animals if burrowing problems continue to occur (filling and compacting). If the problem persists, vector control specialists will be consulted regarding removal steps. This consulting is

necessary as the threat of rabies in some areas may necessitate the animals being destroyed rather than relocated.

- General Facility Maintenance. In addition to the above elements of corrective maintenance, general corrective maintenance will address the overall facility and its associated components. If corrective maintenance is being done to one component, other components will be inspected to see if maintenance is needed.

Maintenance Frequency

Maintenance indicators, described above, will determine the schedule of maintenance activities to be implemented at the basin. These basins should not require a rigorous maintenance schedule, once the landscaping is established. The inspection frequency and regular preventative maintenance will indicate when corrective maintenance is necessary.

The detention basins must be inspected at least once during the rainy season and at least once between each rainy season. These basins must be maintained so that they continue to function as designed. All inspections and maintenance activities will be documented for submittal to the County of Imperial and the Regional Water Quality Control Board if requested.

ATTACHMENTS

ATTACHMENT 1

Colorado River Basin 303(d) List

2006 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SEGMENTS REQUIRING TMDLS

COLORADO RIVER BASIN REGIONAL WATER QUALITY CONTROL BOARD

USEPA APPROVAL DATE: JUNE 28, 2007

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
7	R	Alamo River	72310000				
				Chlorpyrifos	Source Unknown	57 Miles	2019
				DDT	Source Unknown	57 Miles	2019
				Dieldrin	Source Unknown	57 Miles	2019
				PCBs (Polychlorinated biphenyls)	Source Unknown	57 Miles	2019
				Selenium *Selenium originates from Upper Basin Portion of Colorado River. Elevated fish tissue levels. For 2006, selenium was moved by USEPA from the being addressed list back to the 303(d) list pending completion and USEPA approval of a TMDL.*	Agricultural Return Flows	57 Miles	2003
				Toxaphene	Source Unknown	57 Miles	2019
7	R	Coachella Valley Storm Water Channel	71947000				
				Pathogens *This listing for pathogens only applies to a 17 mile area of the Coachella Valley Storm Water Channel from Dillion Road to the Salton Sea.*	Source Unknown	24 Miles	2006
				Toxaphene *This listing for toxaphene only applies to a 2 mile area of the Coachella Valley Storm Water Channel from Lincoln Street to the Salton Sea.*	Source Unknown	24 Miles	2019
7	R	Colorado River (Imperial Reservoir to California-Mexico Border)	72700000				
				Selenium	Source Unknown	11 Miles	2019

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
7	R	Imperial Valley Drains	72310000				
				DDT		1225 Miles	2019
				The listing for DDT only applies to the Barbara Worth Drain, Peach Drain, and Rice Drain areas of the Imperial Valley drains.			
					Source Unknown		
				Dieldrin		1225 Miles	2019
				The listing for dieldrin only applies to the Barbara Worth Drain and Fig Drain areas of the Imperial Valley drains.			
					Source Unknown		
				Endosulfan		1225 Miles	2019
				The listing for endosulfan only applies to the Peach Drain area of the Imperial Valley drains.			
					Source Unknown		
				PCBs (Polychlorinated biphenyls)		1225 Miles	2019
				The listing for PCBs only applies to the Central Drain area of the Imperial Valley drains, from Meloland Road to the outlet into the Alamo River.			
					Source Unknown		
				Selenium		1225 Miles	2019
				Selenium originates from Upper Basin Portion of Colorado River. Elevated fish tissue levels.			
					Agricultural Return Flows		
				Toxaphene		1225 Miles	2019
				This listing for toxaphene only applies to the Barbara Worth Drain, Peach Drain, and Rice Drain of the Imperial Valley drains.			
					Source Unknown		
7	R	New River (Imperial County)	72800000				
				1,2,4-Trimethylbenzene		66 Miles	2006
					Industrial Point Sources		
					Out-of-state source		
				Chlordane		66 Miles	2019
					Source Unknown		
				Chloroform		66 Miles	2006
					Industrial Point Sources		
					Out-of-state source		
				Chlorpyrifos		66 Miles	2019
					Source Unknown		

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
				Copper		66 Miles	2019
				This listing was made by USEPA for 2006.			
					Source Unknown		
				DDT		66 Miles	2019
					Source Unknown		
				Diazinon		66 Miles	2019
					Source Unknown		
				Dieldrin		66 Miles	2019
					Source Unknown		
				Mercury		66 Miles	2019
					Source Unknown		
				meta-para xylenes		66 Miles	2006
					Industrial Point Sources		
					Out-of-state source		
				Nutrients		66 Miles	2006
				Regional Board proposes to establish TMDL in cooperation with U.S. EPA and Mexico.			
					Major Municipal Point Source-dry and/or wet weather discharge		
					Agricultural Return Flows		
					Out-of-state source		
				Organic Enrichment/Low Dissolved Oxygen		66 Miles	2006
					Wastewater		
					Inappropriate Waste Disposal/Wildcat Dumping		
					Out-of-state source		
					Unknown point source		
				o-Xylenes		66 Miles	2006
					Industrial Point Sources		
					Out-of-state source		

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
				PCBs (Polychlorinated biphenyls)		66 Miles	2019
					Source Unknown		
				p-Cymene		66 Miles	2006
					Industrial Point Sources Out-of-state source		
				p-Dichlorobenzene/DCB		66 Miles	2006
					Industrial Point Sources Out-of-state source		
				Pesticides		66 Miles	2019
					Agricultural Return Flows Out-of-state source		
				Selenium		66 Miles	2019
					Source Unknown		
				Toluene		66 Miles	2006
					Industrial Point Sources Out-of-state source		
				Toxaphene		66 Miles	2019
					Source Unknown		
				Toxicity		66 Miles	2019
					Source Unknown		
				Trash		66 Miles	2006
					Out-of-state source		
7	R	Palo Verde Outfall Drain and Lagoon	71540000	DDT		19 Miles	2019
					Source Unknown		

2006 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SEGMENTS REQUIRING TMDLS

COLORADO RIVER BASIN REGIONAL WATER QUALITY CONTROL BOARD

USEPA APPROVAL DATE: JUNE 28, 2007

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION
				Pathogens		19 Miles	2019
				This listing was made by USEPA for 2006.			
					Source Unknown		
7	S	Salton Sea	72800000				
				Nutrients		233340 Acres	2006
					Major Industrial Point Source		
					Agricultural Return Flows		
					Out-of-state source		
				Salinity		233340 Acres	2019
				TMDL development will not be effective in addressing this problem, which will require an engineering solution with federal, local, and state cooperation.			
					Agricultural Return Flows		
					Out-of-state source		
					Point Source		
				Selenium		233340 Acres	2019
					Agricultural Return Flows		

2006 CWA SECTION 303(d) LIST OF WATER QUALITY LIMITED SEGMENTS REQUIRING TMDLS

COLORADO RIVER BASIN REGIONAL WATER QUALITY CONTROL BOARD

USEPA APPROVAL DATE: JUNE 28, 2007

REGION	TYPE	NAME	CALWATER WATERSHED	POLLUTANT/STRESSOR	POTENTIAL SOURCES	ESTIMATED SIZE AFFECTED	PROPOSED TMDL COMPLETION

ABBREVIATIONS

REGIONAL WATER QUALITY CONTROL BOARDS

1 North Coast
2 San Francisco Bay
3 Central Coast
4 Los Angeles
5 Central Valley
6 Lahontan
7 Colorado River Basin
8 Santa Ana
9 San Diego

WATER BODY TYPE

B = Bays and Harbors
C = Coastal Shorelines/Beaches
E = Estuaries
L = Lakes/Reserviors
R = Rivers and Streams
S = Saline Lakes
T = Wetlands, Tidal
W= Wetlands, Freshwater

CALWATER WATERSHED

"Calwater Watershed" is the State Water Resources Control Board hydrological subunit area or an even smaller area delineation.

GROUP A PESTICIDES OR CHEM A

aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane (including lindane), endosulfan, and toxaphene

ATTACHMENT 2

Site Map (BMP Location Map)

Figure 2: Site Map (BMP Location Map)

Tory R. Walker Engineering, Inc.
Water Resources Planning & Engineering

ATTACHMENT 3

BMP Datasheets

Extended Detention Basin

TC-22

Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

Targeted Constituents

☑	Sediment	▲
☑	Nutrients	●
☑	Trash	■
☑	Metals	▲
☑	Bacteria	▲
☑	Oil and Grease	▲
☑	Organics	▲

Legend ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.

- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.

- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

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relationships resulting from the increase of impervious cover in a watershed.

Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).

- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.

- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.

- Outlet designed to discharge the capture volume over a period of hours.

- Length to width ratio of at least 1.5:1 where feasible.

- Basin depths optimally range from 2 to 5 feet.

- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.

- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.

- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.

- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

Figure 1
Example of Extended Detention Outlet Structure

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

Summary of Design Recommendations

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2gH-H_o)^{0.5}$$

where:
Q = discharge (ft^3/s)
C = orifice coefficient
A = area of the orifice (ft^2)
g = gravitational constant (32.2)
H = water surface elevation (ft)
H_o= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to H_o. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

Cost

Construction Cost

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume (ft^3).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

Maintenance Cost

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

Table 1 Estimated Average Annual Maintenance Effort

Activity	Labor Hours	Equipment & Material ($)	Cost
Inspections	4	7	183
Maintenance	49	126	2282
Vector Control	0	0	0
Administration	3	0	132
Materials	-	535	535
Total	**56**	**$668**	**$3,132**

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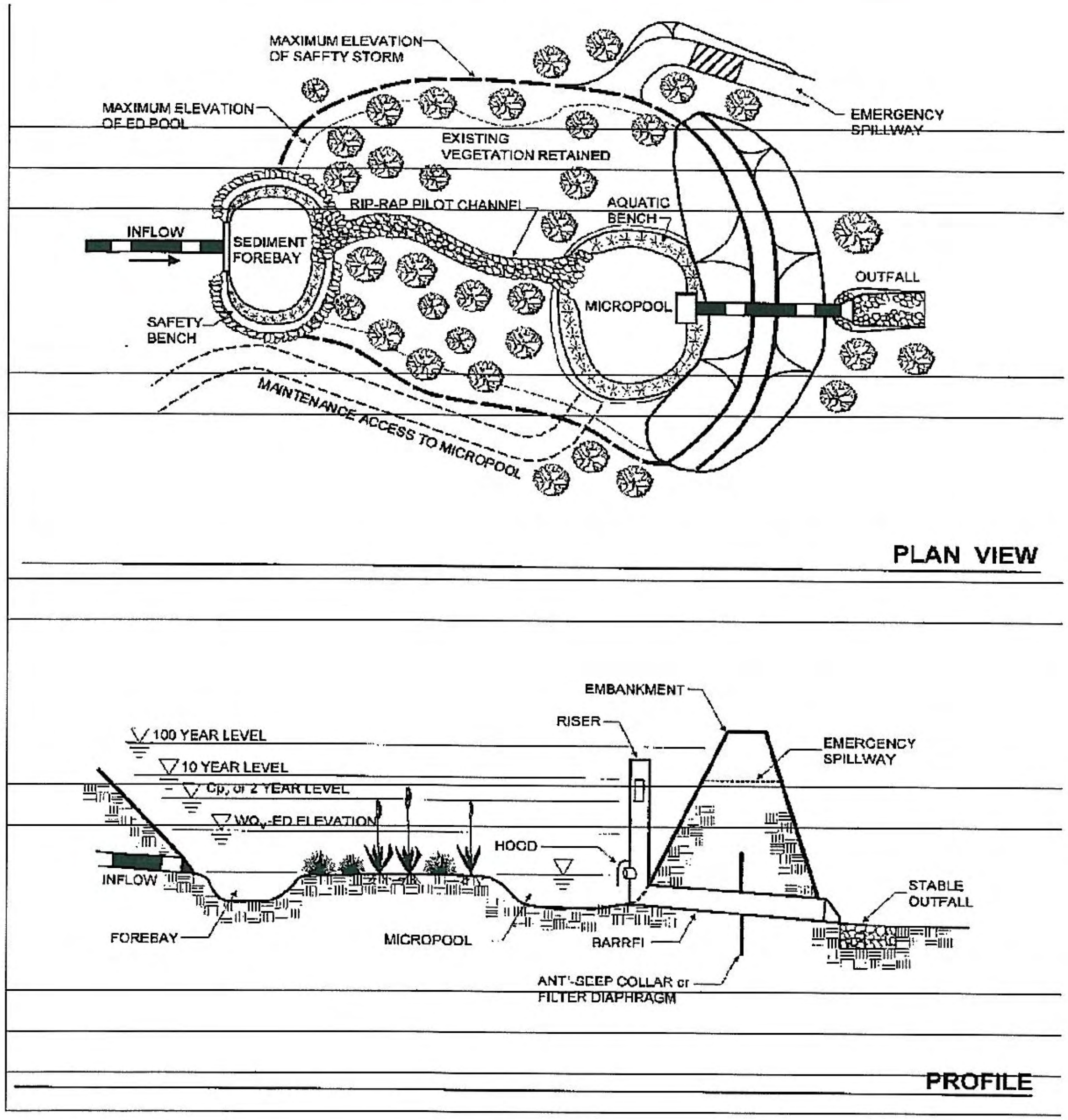

Schematic of an Extended Detention Basin (MDE, 2000)